



TI-*nspire*[™]
CAS

Learning and Technology Handheld

Part 2

This guidebook applies to TI-Nspire™ software version 1.4. To obtain the latest version of the documentation, go to education.ti.com/guides.

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Introduction

The TI-Nspire™ CAS math and science learning handheld

This guidebook provides information about a powerful, advanced learning handheld available from Texas Instruments: the TI-Nspire™ CAS handheld.

Your learning handheld comes equipped with a variety of pre-installed software applications that have features relevant to many different subjects and curriculums.

Extend the reach of your TI-Nspire™ CAS handheld with accessories, such as the TI-Nspire™ CAS math and science learning software, TI-Nspire™ ViewScreen™ Panel, TI-Nspire™ Connections Cradle and TI-Nspire™ Computer Link Software.

How to use this guidebook

This guidebook is intended to supplement the printed guidebook that accompanied your TI-Nspire™ CAS handheld.

The chapters in this guidebook include:

Transferring Files - Provides instruction for connecting and transferring data and files between two TI-Nspire™ CAS handhelds.

Memory Management - Includes instruction for checking memory on your handheld, and freeing memory if you need additional space.

Using the TI-Nspire™ Computer Link Software - Provides instruction for transferring documents between handhelds, capturing images from your handheld, backing up contents and updating the Operating System (OS) on your TI-Nspire™ CAS handheld.

Using Calculator - Provides detailed instruction for using the Calculator application.

Using Graphs & Geometry - Provides detailed instruction for using the Graphs & Geometry application.

Using Lists & Spreadsheet - Provides detailed instruction for using the Lists & Spreadsheet application.

Using Data & Statistics - Provides detailed instruction for using the Data & Statistics application.

Using Notes - Provides detailed instruction for using the Notes application.

Libraries - Provides detailed instruction for using TI-Nspire™ libraries of variables, functions, and/or programs that have been defined as library objects

Programming - Provides detailed instruction for using user-defined functions and programs.

Data Collection - Provides detailed steps for collecting experimental information from a sensor and automatically display it in a table and/or graph for analysis.

Service and Warranty Information - Includes service and warranty information and contact information for technical support.

Where to find more information

Additional product information is available in printed guidebook that accompanied your TI-Nspire™ CAS handheld. An electronic version of the printed guidebook for using the TI-Nspire™ CAS handheld is included on the CD-ROM that came with your learning handheld. This guidebook is also available online as a free download at education.ti.com/guides.

Transferring Files

Connecting two handhelds

This chapter describes how to connect one TI-Nspire™ CAS handheld to another, and how to transfer files between them. The TI-Nspire™ CAS handheld has a USB port which allows it to communicate with another TI-Nspire™ CAS handheld.

When the TI-Nspire™ CAS handheld is using TI-Nspire™ TI-84 Plus keypad, it can connect with another TI-Nspire™ CAS handheld using the TI-Nspire™ TI-84 Plus keypad or a TI-84 Plus using the USB port or the I/O port.

Using connection cables

Your TI-Nspire™ CAS handheld comes with connection cables that allow you to share files with both a computer and another handheld.

USB cables

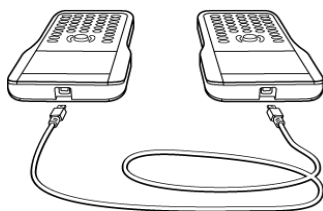
You can use USB cables to connect two TI-Nspire CAS handhelds, to connect a TI-Nspire CAS handheld to a computer.

Connecting two TI-Nspire™ CAS handhelds with the USB unit-to-unit cable

You can connect two handhelds this way as long as both handhelds are using the same keypad. You cannot connect a handheld using the TI-Nspire™ TI-84 Plus keypad to a handheld using the native TI-Nspire keypad.

The TI-Nspire™ CAS handheld USB A port is located at the center of the top of the TI-Nspire CAS handheld.

1. Firmly insert either end of the USB unit-to-unit cable into the USB A port.
2. Insert the other end of the cable into the receiving unit's USB A port.



Backing up files to a computer

Use the TI-Nspire™ Computer Link Software software to back up the contents of your handheld to a computer. TI-Nspire™ Computer Link Software is available on the product CD that came with your handheld.

Transferring documents

Rules for transferring files

- You can transfer documents and Operating System (OS) files.
- If a document with the same name as the one you are sending already exists on the receiving TI-Nspire™ handheld, the document will be renamed. The system appends a number to the name to make it unique. For example, if Mydata existed on the receiving TI-Nspire™ handheld, it would be renamed Mydata(2).
Both the sending and receiving units will display a message that shows the new name.
- There is a 255-character maximum length for a file name, including the entire path. If a transmitted file has the same name as an existing file on the receiving unit and the file names contain 255 characters, then the name of the transmitted file will be truncated to enable the software to follow the renaming scheme described in the previous bullet.
- All variables associated with the document being transmitted are transferred with the document.
- Transmissions will time out after 30 seconds.

Sending a document

1. Open My Documents.

Press  .

2. Press the ▲ and ▼ keys on the NavPad to highlight the document you want to send.

3. Select **Send** from the My Documents menu.

Press    .

4. The file transfer begins. A progress bar displays to allow you to follow the transfer. There is also a cancel button on the Sending... dialog to enable you to cancel the transmission while it in progress.




At the end of a successful transmission, the message "<Folder / File name> transferred as <Folder / File name>." displays. If the file had to be renamed on the receiving unit, the message will display the new file name.

Receiving a document



No action is required by the user of the receiving TI-Nspire™ CAS handheld. Units are automatically powered on when the cable is attached.

At the end of a successful transmission, the message "<Folder / File name> received." displays. If the file had to be renamed, the message will display the new file name.

Canceling a transfer

1. To cancel a transmission in-progress, press Cancel on the dialog of the sending unit. The user of either unit can also press .
2. A link transmission error message displays.
3. Press  or  to cancel the transmission error message.

Common error and notification messages

Shown on:	Message and Description
Sending unit	<div style="border: 1px solid black; padding: 10px; text-align: center;">"Transfer failed. Check cable and try again." OK</div> <p>This message displays if a cable is not attached to the sending unit's link port. Remove and then reinsert the cable and try the document transmission again.</p> <p>Press  or  to cancel the transmission message.</p> <p>Note: The sending unit may not always display this message. Instead, it may remain BUSY until you cancel the transmission.</p>

Shown on: Message and Description

Sending unit

"Receiver does not have enough storage space for file transfer."

OK

This message displays when the receiving unit does not have enough memory to accept the file being transmitted.

The user of the receiving unit must free space in order to obtain the new file. To do this:

- Delete unneeded files.
- Store files on a computer for later retrieval, then delete them from the TI-Nspire™ CAS handheld.

Sending unit

"<folder>/<filename>
transferred as
<folder>/<filename(#)>."

This message displays at the end of a successful transfer when the file had to be renamed because a file already exists on the receiving unit with the original name. The transmitted file is renamed by appending a number to the end of the name. Rename numbering always begins with (2) and can increment by one, as needed.

Shown on: Message and Description

Sending unit

"<folder>/<filename>
transferred as
<folder>/<new filename>."

This message displays when a new folder is created on the receiving unit to contain the transmitted document.

Receiving unit

"<folder>/<filename(x)>
received."

This message displays if the receiving unit has a document with the same name as the document being sent.

Receiving unit

"<new folder>/<new filename>
received."

This message displays when a new folder has been created to contain the transmitted document.



Shown on: Message and Description

Receiving unit

"Transfer failed. Check cable
and try again."

OK

This message displays if the cable is not correctly attached to the receiving unit's link port. Remove the cable then reattach it and try the transmission again.

Press  or  to cancel the transmission message.

Upgrading the Operating System

You can upgrade the OS on your TI-Nspire™ CAS handheld using your computer and TI-Nspire™ Computer Link Software. You can also transfer the OS from one unit to another.

OS upgrade operations do not delete user documents. If there is not enough room on the receiving handheld for the upgrade, the sending handheld is notified. The only time documents can be affected by an OS installation is if the receiving handheld has a corrupted OS. In this situation, documents may be affected by OS restoration. It is a good practice to back up your important documents and folders before installing an updated operating system.

See the important information concerning batteries before performing an OS upgrade.

Important Operating System download information

It is always a good practice to install new batteries before beginning an OS download.

When in OS download mode, the Automatic Power Down™ (APD) feature does not function. If you leave your handheld in download mode for an extended time before you begin the downloading process, your batteries may become depleted. You will then need to replace the batteries with new batteries before downloading.

Where to get Operating System upgrades

For up-to-date information about available OS upgrades, check the Texas Instruments Web site at <http://education.ti.com>.

You can download an OS upgrade from the Texas Instruments Web site to a computer, and use a USB computer cable to install the OS on your TI-Nspire™ CAS handheld.

For complete information, refer to the instructions in the chapter on TI-Nspire™ Computer Link Software.

Transferring the Operating System

To transfer the OS from unit to unit:

1. Connect the two units. (For details, see the connection instructions at the beginning of this chapter.) Any open documents on the receiving unit should be closed before the transfer begins.
2. On the sending unit, open My Documents.

Press  .

3. From the menu, select **Send OS**.

Press  .

4. On the receiving unit, the message, "You are receiving an OS Upgrade. Unsaved changes will be lost. Would you like to continue?" displays along with Yes and No response buttons. Select Yes to receive the OS upgrade.

Notes:

- If Yes is not selected within 30 seconds, the unit automatically responds with No, and the transmission is cancelled.
 - It is important to save and close all open documents before performing an OS Upgrade. Continuing with an OS Upgrade on a unit with an open, unsaved document will cause the loss of that data.
5. While the upgrade is in progress, the receiving unit displays, "Receiving OS. Do not unplug cable." The sending unit displays, "Sending OS. Do not unplug cable."
 6. After the transfer completes, the sending unit receives a completion message and can unhook the cable. On the receiving unit, the OS must be installed. This happens automatically. During the installation process, the receiving unit displays the message, "Installing OS <version number>."
 7. When the installation completes, the unit displays the following message, "OS <version number> has been installed. Handheld will now restart." The restart is initiated. If the sending unit is still attached to the cable, the successful transmission message remains displayed on that unit's screen.

Important:

- For each receiving unit, remember to back up information, as necessary, and install new batteries.
- Be sure the sending unit is on the **Send OS** screen.

OS Upgrade Messages

This section lists the information and error messages that can be displayed on units during an OS Upgrade.

Shown on:	Message and Description
Sending unit	<div style="border: 1px solid black; padding: 10px; text-align: center;">"Receiver does not have enough storage space. Make <xxxK> available."</div> <p>This message displays when the receiving unit does not have enough memory available for the new OS. The space requirement is shown so you know how much memory must be cleared for the new operating system. Files can be moved to a computer for storage to free the necessary space.</p>
Sending unit	<div style="border: 1px solid black; padding: 10px; text-align: center;">"Receiver must change batteries before upgrading the OS."</div> <p>This message displays when the batteries in the receiving unit need to be replaced. Send the OS Upgrade once the batteries are replaced.</p>
Sending unit	<div style="border: 1px solid black; padding: 10px; text-align: center;">"Receiver has a newer OS and cannot load this OS." OK</div> <p>This message displays when the receiving unit has a newer OS version than the one being transmitted. You cannot downgrade an OS.</p>

Shown on:	Message and Description
------------------	--------------------------------

Sending unit

"Upgrade not accepted by receiver."

OK

This message displays when the receiving unit refuses the upgrade.

Sending unit

"OS has been transferred.
You can now unplug."

OK

This message displays when the transfer is completed and it is safe for the sending unit to unplug the cable.

Sending unit

"Sending OS. Do not unplug cable."

This message, along with a progress bar, displays while the OS Upgrade is being transferred.

Both units

"Transfer failed. Check cable and try again."

OK

The sending and/or receiving unit is not properly connected. Reinsert the cable into each handheld, then try the transmission again.

Shown on: Message and Description

Receiving unit

"You are receiving an OS Upgrade. Unsaved changes will be lost. Would you like to continue?"

Yes No

This message displays when an OS Upgrade is about to begin. If you do not select Yes within 30 seconds, the system automatically responds with No.

Receiving unit

"Receiving OS. Do not unplug cable."

This message, along with a progress bar, displays while the OS Upgrade is being transferred.

Receiving unit

"Installing OS."

This message displays once the transfer is completed. It is shown to keep you informed of the unit's status.

Receiving unit

"OS has been installed. Handheld will restart."

OK

This information message displays briefly before the unit automatically reboots.

Shown on:	Message and Description
------------------	--------------------------------

Receiving unit

"Install was corrupted.
Handheld will reboot. You
will need to retry OS
upgrade."

OK

An error occurred during the transmission, and the installation was corrupted. The unit will reboot. After the reboot, reinstall the OS Upgrade.

Memory and file management




Checking available memory

The Handheld Status screen shows the amount of memory (in bytes) used by all documents and variables on your TI-Nspire™ CAS handheld. The Handheld Status screen displays the following information:

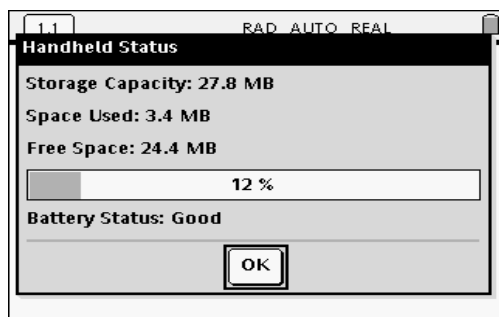
- Storage Capacity
- Space Used
- Free Space
- Battery Status

Displaying the Handheld Status screen

- ▶ Select **Handheld Status** from the **Home** menu.

Press   

The Handheld Status window displays.



Freeing memory

If you have insufficient memory to store documents on your handheld, you must free memory to create the space you need. To free memory, you must delete documents and/or folders from memory. If you wish to keep the documents and folders for use later, you can back them up to another handheld or to a computer.



Deleting items from memory

If you have documents stored on your TI-Nspire™ CAS handheld that you no longer need, you can delete them from memory to create additional space.

Before you delete documents from memory, consider restoring sufficient available memory by copying files to another handheld.

1. Open **My Documents**.

Press  .

2. Press  or  to select the folder or document you want to delete.

3. Select **Delete**.

Press    .

The folder/document is permanently removed from the handheld.

Backing up files to another handheld

To back up files to another TI-Nspire™ CAS handheld, follow the steps below. Complete instructions for connecting two handhelds are provided in the Connectivity chapter.

1. Connect the two handhelds using the USB-to-USB Connectivity Cable.

2. Open **My Documents** on the sending unit.

Press  .

3. Press the  and  keys to highlight the document you want to send.

4. Select **Send** from the **Document** menu.

Press    .

5. When the file transfer is complete, a message displays on the receiving unit.

Backing up files to a computer

Use the TI-Nspire™ Computer Link software to back up the contents of your handheld to a computer. TI-Nspire™ Computer Link software is available on the product CD that came with your handheld.

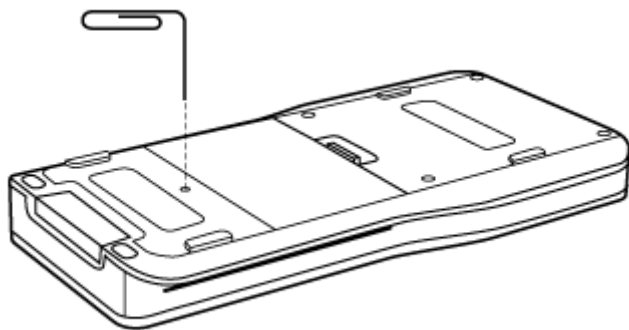
Resetting the memory

The Reset button on the underside of the handheld resets all memory. When resetting all memory on the TI-Nspire™ CAS handheld, RAM and Flash memory is restored to factory settings. All files will be deleted. All system variables are reset to default settings.

Caution: Before you reset all memory, consider restoring sufficient available memory by deleting only selected data.

To reset all memory on the handheld, follow these steps.

1. Use a paper clip or ball point pen to press the reset button on the underside of the handheld.



2. Hold for three seconds and release.

Handheld memory is cleared.

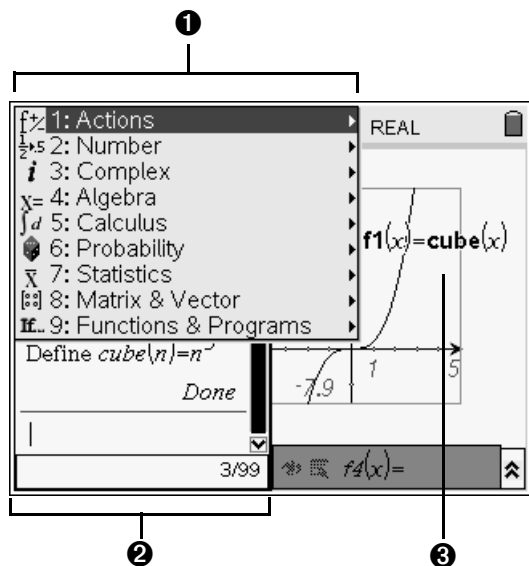
When you clear memory, the contrast sometimes changes. If the screen is faded or blank, adjust the contrast by pressing **ctrl** **+** or **ctrl** **-**.

Using Calculator

Getting started with the Calculator application

The Calculator application gives you a place to enter and evaluate math expressions. You can also use it to define variables, functions, and programs. When you define or edit a variable, function, or program, it becomes available to any TI-Nspire™ math and science learning technology application—such as Graphs & Geometry—that resides in the same problem.

You can also use Calculator to define library objects, such as variables, functions, and programs, which are accessible from any problem of any document. For information on creating library objects, see the “Libraries” section of the documentation.





- 1 Calculator menu – This menu is available anytime you are in the Calculator work area. Press **(menu)** to display the menu. The menu in this screen snapshot may not exactly match the menu on your screen.
- 2 Calculator work area
 - You enter a math expression on the entry line and then press **(enter)** to evaluate the expression.
 - Expressions display in standard mathematical notation as you enter them.



- Entered expressions and results show in the Calculator history.



③ Example of Calculator variables used in another application


The Calculator tool menu


The Calculator tool menu lets you enter and evaluate a variety of math expressions.

Menu Name	Menu Option	Function
 Actions		
	Define	Inserts the Define command.
	Recall Definition	Lets you view, reuse, or modify a function or program that you have defined.
	Delete Variable	Inserts the delVar command.
	Clear a-z	Deletes all variables with single-letter names.
	Clear History	Deletes all expressions in the Calculator history.
	Insert Comment	Lets you insert text.
	Library	Lets you refresh all libraries, set LibPub or LibPriv access, insert a “\” character, or create a library shortcut.
 Number		
	Convert to Decimal	Inserts ►Decimal command.
	Factor	Inserts factor() .
	Least Common Multiple	Inserts lcm() .
	Greatest Common Divisor	Inserts gcd() function.
	Remainder	Inserts remain() .
	Fraction Tools	Lets you select propFrac() , getNum() , getDenom() , or comDenom() .

Menu Name	Menu Option	Function
	Number Tools	Lets you select round() , iPart() , fPart() , sign() , mod() , floor() , or ceiling() .
	Complex Number Tools	Lets you select conj() , real() , imag() , angle() , ►Polar , ►Rect , or the absolute value template.
 Algebra		
	Solve	Inserts solve() .
	Factor	Inserts factor() .
	Expand	Inserts expand() .
	Zeros	Inserts zeros() .
	Numerical Solve	Inserts nSolve() .
	Polynomial Tools	Lets you select polyRemainder() , polyQuotient() , polyGcd() , polyCoeffs() , or polyDegree() .
	Fraction Tools	Lets you select propFrac() , getNum() , getDenom() , or comDenom() .
	Convert Expression	Lets you select ►cos , ►sin , or ►Exp .
	Trigonometry	Lets you select tExpand() or tCollect() .
	Complex	Lets you select cSolve() , cFactor() , or cZeros() .
	Extract	Lets you select left() or right() .
	Finance Solver	Starts the Finance Solver.
 Calculus		
	Derivative	Inserts the Derivative template.
	Integral	Inserts the Integral template.

Menu Name	Menu Option	Function
	Limit	Inserts the Limit template.
	Sum	Inserts the Sum template.
	Product	Inserts the Product template.
	Function Minimum	Inserts fMin() .
	Function Maximum	Inserts fMax() .
	Tangent Line	Inserts tangentLine() .
	Normal Line	Inserts normalLine() .
	Arc Length	Inserts arcLen() .
	Series	Lets you select taylor() , series() , or dominantTerm() .
	Differential Equation Solver	Inserts deSolve() .
	Implicit Differentiation	Inserts impDif() .
	Numerical Calculations	Lets you select nDeriv() , nInt() , nfMin() , or nfMax()
 Probability		
	Factorial (!)	Inserts ! .
	Permutations	Inserts nPr() .
	Combinations	Inserts nCr() .
	Random	Lets you select rand() , randInt() , randBin() , randNorm() , randSamp() , or RandSeed .
	Distributions	Lets you select from several distributions, such as Normal Pdf , Binomial Cdf , and Inverse F .
 Statistics		

Menu Name	Menu Option	Function
	Stat Calculations	Lets you select from several statistics calculations, such as one-variable analysis, two-variable analysis, and regressions.
	Stat Results	Inserts the <i>stat.results</i> variable.
	List Math	Lets you select from several list calculations, such as minimum, maximum, and mean.
	List Operations	Lets you select from several list operations, such as sorting, filling, and converting to a matrix.
	Distributions	Lets you select from several distributions, such as Normal Pdf , Binomial Cdf , and Inverse F .
	Confidence Intervals	Lets you select from several confidence intervals, such as t interval and z interval .
	Stat Tests	Lets you select from several tests such as ANOVA , t test , z test .
 Matrix & Vector		
	Transpose	Inserts T .
	Determinant	Inserts det() .
	Row-Echelon Form	Inserts ref() .
	Reduced Row-Echelon Form	Inserts rref() .
	Simultaneous	Inserts simult() .

Menu Name	Menu Option	Function
	Create	Lets you select from several matrix-creation options, such as construct matrix, identity, diagonal, submatrix, and others.
	Norms	Lets you select norm() , rowNorm() , or colNorm() .
	Dimensions	Lets you select dim() , rowDim() , or colDim() .
	Row Operations	Lets you select rowSwap() , rowAdd() , mRow() , or mRowAdd() .
	Element Operations	Inserts "dot" operators such as .* (dot add) and .^ (dot power).
	Advanced	Inserts trace() , LU , QR , eigVl() , eigVc() , or charPoly() ,
	Vector	Inserts unitV() , crossP() , dotP() , ►Polar , ►Rect , ►Cylind , or ►Sphere .
 Functions & Programs		
	Program Editor	Lets you view, open for editing, import, or create a new program or function.
	Func...EndFunc	Inserts a template for creating a function.
	Prgm...EndPrgm	Inserts a template for creating a program.
	Local	Inserts the Local command.
	Control	Lets you select from a list of function and program-control templates, such as If...Then...EndIf , While...EndWhile , Try...Else...EndTry , and others.

Menu Name	Menu Option	Function
	Transfer	Inserts transfer commands Return, Cycle, Exit, Lbl, Stop, or Goto .
	Disp	Displays intermediate results.
	Mode	Inserts commands for setting or reading modes, such as display digits, angle mode, base mode, and others. Also lets you get the current language information.
	Add New Line	Starts a new line within a function or program definition.


Before you begin

- ▶ Turn on the handheld, and add a Calculator application to a document.


Entering and evaluating math expressions

Options for entering expressions

Calculator lets you enter and edit expressions through several methods.

- By pressing keys on the handheld keypad.
- By selecting items from the Calculator menu.
- By selecting items from the Catalog ()

Entering simple math expressions

Note: To enter a negative number on the handheld, press . To enter a negative number on a computer keyboard, press the hyphen key (-).

Suppose you want to evaluate $\frac{2^8 \cdot 43}{12}$

1. Select the entry line in the Calculator work area.
2. Type 2^8 to begin the expression.

2^8

3. Press \blacktriangleright to return the cursor to the baseline, and then type:

$$2^8 \cdot 43 / 12 .$$

$$2^8 \cdot 43 / 12$$

4. Press $\frac{\approx}{\text{enter}}$ to evaluate the expression.

The expression displays in standard mathematical notation, and the result displays on the right side of the Calculator.

$$\frac{2^8 \cdot 43}{12} \qquad \frac{2752}{3}$$

Note: If a result does not fit on the same line with the expression, it displays on the next line.

Controlling the form of a result

You might expect to see a decimal result instead of $2752/3$ in the preceding example. A close decimal equivalent is $917.33333\dots$, but that's only an approximation.

By default, Calculator retains the more precise form: $2752/3$. Any result that is not a whole number displays in a fractional or symbolic form ($1/2$, π , $\sqrt{2}$, etc.). This reduces rounding errors that could be introduced by intermediate results in chained calculations.

You can force a decimal approximation in a result:

- By pressing $\text{ctrl} \frac{\approx}{\text{enter}}$ instead of $\frac{\approx}{\text{enter}}$ to evaluate the expression.

$$\frac{2^8 \cdot 43}{12} \qquad 917.333$$

Pressing $\text{ctrl} \frac{\approx}{\text{enter}}$ forces the approximate result.

- By including a decimal in the expression (for example, $43 .$ instead of 43).

$$\frac{2^8 \cdot 43 .}{12} \qquad 917.333$$

- By wrapping the expression in the **approx()** function.

$$\text{approx}\left(\frac{2^{8.43}}{12}\right) \qquad 917.333$$

- By changing the document's **Auto or Approximate** mode setting to Approximate.

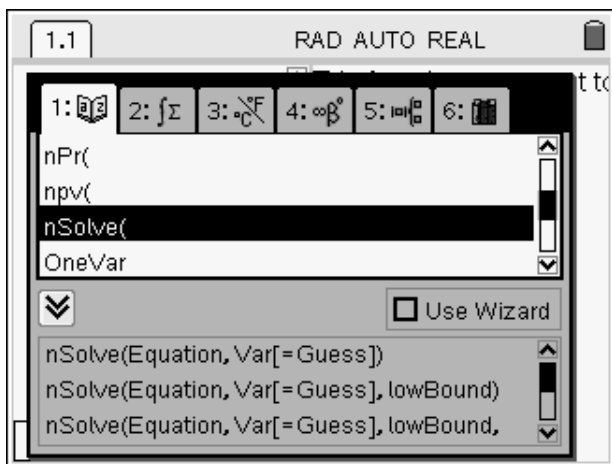
- Press $\text{ctrl} + \text{Alt} + 1$ to display the **File** menu, and then select **Document Settings**.

Note that this method forces all results in all of the document's problems to approximate.

Inserting items from the Catalog

You can use the Catalog to insert system functions and commands, units, symbols, and expression templates into the Calculator entry line.

- Press $\text{ctrl} + \text{Alt} + \text{C}$ to open the Catalog.



Note: Some functions have a wizard that prompts you for each argument. If you prefer to enter the argument values directly on the entry line, you may need to disable the wizard.

- Press the number key for the category of the item. For example, press 1 to show the alphabetic list.



1: Contains all commands and functions, in alphabetical order.



2: Contains all math functions.



3: Provides the values for standard measurement units.



4: Provides a symbol palette for adding special characters.



5: Contains math templates for creating two dimensional objects, including product, sum, square root and integral.



6: Shows Public library (LibPub) objects.

3. Press \blacktriangledown and then use \blacktriangleleft , \blacktriangleright , \blacktriangleup , or \blacktriangledown as necessary to select the item that you want to insert.

Note: To see syntax examples of the selected item, press tab , and then press enter to alternately show or hide the Help. To move back to the selected item, press caps tab .

4. Press enter to insert the item into the entry line.

Using an expression template

The Calculator has templates for entering matrices, piecewise functions, systems of equations, integrals, derivatives, products, and other math expressions.

For example, suppose you want to evaluate $\sum_{n=3}^7 (n)$

1. Press ctrl math to open the Template palette.


2. Select $\sum_{a=b}^c$ to insert the algebraic sum template.

The template appears on the entry line with small blocks representing elements that you can enter. A cursor appears next to one of the elements to show that you can type a value for that element.

$$\sum_{i=0}^0 (0)$$

- Use the arrow keys to move the cursor to each element's position, and type a value or expression for each element.

$$\sum_{n=3}^7 (n)$$

- Press  to evaluate the expression.

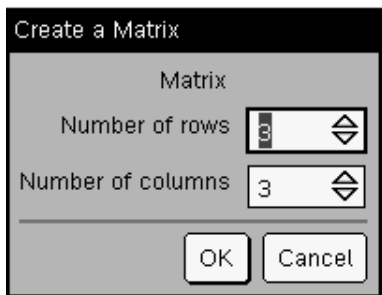
$$\sum_{n=3}^7 (n) \qquad 25$$

Creating matrices

- Press   to open the Template palette.

- Select .

The Create a Matrix dialog box displays.



3. Type the **Number of rows**.
4. Type the **Number of columns**, and then select **OK**.
Calculator displays a template with spaces for the rows and columns.
Note: If you create a matrix with a large number of rows and columns, it may take a few moments to appear.
5. Type the matrix values into the template, and press enter to define the matrix.

Inserting a row or column into a matrix

- ▶ To insert a new row, press ↵ .
- ▶ To insert a new column, hold down tab and press enter .





Inserting expressions using a wizard

You can use a wizard to simplify entering some expressions. The wizard contains labeled boxes to help you enter the arguments in the expression.

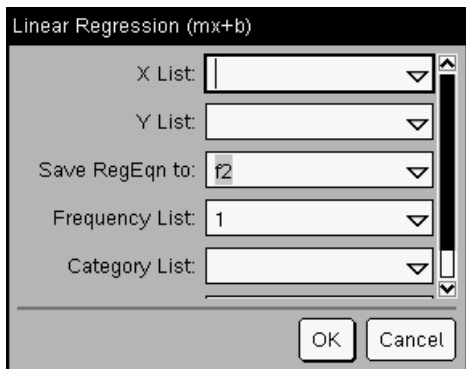
For example, suppose you want to fit a $y=mx+b$ linear regression model to the following two lists:



{1,2,3,4,5}
{5,8,11,14,17}

1. Press 2nd CAT to open the Catalog.
2. Press **1** to show the alphabetic list of functions.
3. Press \blacktriangledown , and then press **L** to jump to the entries that begin with "L."
4. Press \blacktriangledown as necessary to highlight **LinRegMx**.
5. If the Use Wizard option is not checked:
 - a) Press tab tab to highlight the Use Wizard button.

- b) Press  to change the setting.
- c) Press   to highlight **LinRegMx** again.
6. Press .

A wizard opens, giving you a labeled box to type each argument.



7. Type {1, 2, 3, 4, 5} as **X List**.
8. Press  to move to the **Y List** box.
9. Type {5, 8, 11, 14, 17} as **Y List**.
10. If you want to store the regression equation in a specific variable, press , and then replace **Save RegEqn To** with the name of the variable.
11. Select **OK** to close the wizard and insert the expression into the entry line.

Calculator inserts the expression and adds a statement to display the variable *stat.results*, which will contain the results.

LinRegMx {1,2,3,4,5},{5,8,11,14,17},1 : *stat.results*

Calculator then displays the *stat.results* variables.

LinRegMx	{ 1,2,3,4,5 }, { 5,8,11,14,17 }, 1:	<i>stat.results</i>
"Title"	"Linear Regression (mx+b)"	
"RegEqn"	"m*x+b"	
"m"	3.	
"b"	2.	
"r ² "	1.	
"r"	1.	
"Resid"	" {... }"	

Note: You can copy values from the *stat.results* variables and paste them into the entry line.

Creating a piecewise function

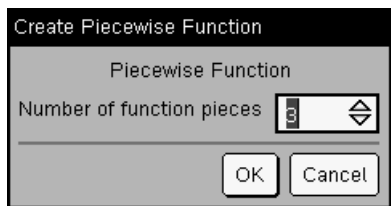
1. Begin the function definition. For example, type the following.

Define $f(x, y) =$

2. Press $\text{ctrl} + \text{m} \frac{\text{m}}{\text{x}}$ to open the Template palette.

3. Select .

The Piecewise Function dialog box displays.



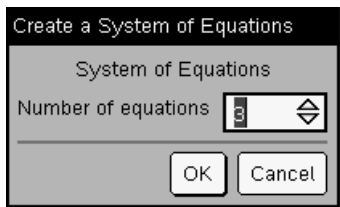
4. Type the **Number of Function Pieces**, and select **OK**.
Calculator displays a template with spaces for the pieces.
5. Type the expressions into the template, and press $\frac{\text{m}}{\text{x}}$ to define the function.
6. Enter an expression to evaluate or graph the function. For example, enter the expression $f(1, 2)$ on the Calculator entry line.


Creating a system of equations

1. Open the Template palette.

2. Select .

The Create a System of Equations dialog box displays.



3. Type the **Number of Equations**, and select **OK**.
Calculator displays a template with spaces for the equations.
4. Type the equations into the template, and press **Enter** () to define the system.

Deferring evaluation

You don't have to complete and evaluate an expression as soon as you begin typing it. You can type part of an expression, leave to check some work you did on another page, and then come back to complete the expression later.

Working with variables

When you first store a value in a variable, you give the variable a name.

- If the variable does not already exist, Calculator creates it.
- If the variable already exists, Calculator updates it.

Variables within a problem are shared by TI-Nspire™ math and science learning technology applications. For example, you can create a variable in Calculator and then use or modify it in Graphs & Geometry or Lists & Spreadsheet within the same problem.

Exception: Variables created with the **Local** command within a user-defined function or program are not accessible outside that function or program.

Storing a value in a variable

This example creates a variable named *num* and stores the result of the expression $5+8^3$ in that variable.

1. On the Calculator entry line, type the expression $5+8^3$.

5+8³|

2. Press **▶** to expand the cursor to the baseline.

5+8³|

3. Press **ctrl** **stop var** and then type the variable name `num`.

5+8³ → **num**|

This means: Calculate $5+8^3$ and store the result as a variable named `num`.

4. Press **enter**.

Calculator creates the variable `num` and stores the result there.

5+8³ → `num` 517

Alternative methods for storing a variable

As alternatives to using **→** (store), you can use “:=” or the **Define** command. All of the following statements are equivalent.

$5+8^3 \rightarrow num$

$num := 5+8^3$

Define $num=5+8^3$

Checking a variable's value

You can check the value of an existing variable by entering its name on the Calculator entry line.

- ▶ On the Calculator entry line, type the variable name `num` and press **enter**.

The value most recently stored in `num` displays as the result.

`num` 517

Using a variable in a calculation

After storing a value in a variable, you can use the variable name in an expression as a substitute for the stored value.

1. Type $4 \cdot 25 \cdot \text{num}^2$ on the entry line, and press enter .

Calculator substitutes 517, the value currently assigned to *num*, and evaluates the expression.

$$4 \cdot 25 \cdot \text{num}^2 \qquad 26728900$$

2. Type $4 \cdot 25 \cdot \text{nonum}^2$ on the entry line, and press enter .

$$4 \cdot 25 \cdot \text{nonum}^2 \qquad 100 \cdot \text{nonum}^2$$

Because the variable *nonum* has not been defined, it is treated algebraically in the result.

Updating a variable

If you want to update a variable with the result of a calculation, you must store the result explicitly.

Entry	Result	Comment
$a := 2$	2	
a^3	8	Result not stored in variable <i>a</i> .
a	2	
$a := a^3$	8	Variable <i>a</i> updated with result.
a	8	
$a^2 \rightarrow a$	64	Variable <i>a</i> updated with result.
a	64	

Types of variables

You can store the following TI-Nspire™ math and science learning technology data types as variables:

Data type	Examples
Expression	2.54 1.25E6 2π $2+3i$ $(x-2)^2$ $\frac{\sqrt{2}}{2}$
List	{2, 4, 6, 8} {1, 1, 2}

Data type	Examples		
Matrix	$\begin{bmatrix} 1 & 2 & 3 \\ 3 & 6 & 9 \end{bmatrix}$	This can be entered as: [1, 2, 3; 3, 6, 9]	
Character string	"Hello"	"xmin/10"	"The answer is:"
Function	myfunc(arg)	ellipse(x, y, r1, r2)	

Entering multiple statements on the entry line

To enter several statements on a single line, separate them with a colon (":"). Only the result of the last expression is shown.

$$a:=5: b:=2: \frac{a}{b} \cdot 1. \qquad 2.5$$

Rules for naming variables

Note: In the unlikely event that you create a variable with the same name as one used for statistical analysis or by the Finance Solver, an error condition could occur. If you begin entering a variable name that is already in use in the current problem, the software shows the entry in **bold** to let you know.

- Variable names must be in one of the forms xxx or $xxx.yyy$. The xxx part can have 1 to 16 characters. The yyy part, if used, can have 1 to 15 characters. If you use the $xxx.yyy$ form, both xxx and yyy are required; you cannot start or end a variable name with a period ".".
- Characters can consist of letters, digits, and the underscore character ($_$). Letters can be U.S. or Greek letters (but not Π or π), accented letters, and international letters.
- Do not use **c** or **n** from the symbol palette to construct a variable name such as **c1** or **n12**. These may appear to be letters, but they are treated internally as special symbols.
- You can use uppercase or lowercase letters. The names $AB22$, $Ab22$, $aB22$, and $ab22$ all refer to the same variable.
- You cannot use a digit as the first character of xxx or yyy .
- Do not use spaces.
- If you want a variable to be treated as a complex number, use an underscore as the last character of the name.

- If you want a variable to be treated as a type of unit (such as *_m* or *_ft*), use an underscore as the first character of the name. You cannot use subsequent underscores in the name.
- You cannot use a preassigned variable, function, or command name, such as *Ans*, **min**, or **tan**.

Note: For a complete list of TI-Nspire™ functions, refer to the Reference Guide.

- Library documents and library objects are subject to additional naming restrictions. For details, see the “Libraries” section of the documentation.

Here are some examples:



Variable names	Valid?
<i>Myvar</i> ; <i>my.var</i>	Yes
<i>My var</i> ; <i>list 1</i>	No. Contains a space.
<i>a, b, c</i>	Yes
<i>Log</i> ; <i>Ans</i>	No. Preassigned to a system function or variable.
<i>Log1</i> ; <i>list1.a</i> ; <i>list1.b</i>	Yes
<i>3rdTotal</i> ; <i>list1.1</i>	No. <i>xxx</i> or <i>yyy</i> starts with a digit.

Reusing the last answer



Each instance of Calculator automatically stores the last calculated result as a variable named *Ans*. You can use *Ans* to create a chain of calculations.

Note: Do not link to *Ans* or any system variable. Doing so could prevent the variable from being updated by the system. System variables include statistics results (such as *Stat.RegEqn*, *Stat.dfError*, and *Stat.Resid*) and Finance Solver variables (such as *tvm.n*, *tvm.pmt*, and *tvm.fv*).

As an example of using *Ans*, calculate the area of a garden plot that is 1.7 meters by 4.2 meters. Then use the area to calculate the yield per square meter if the plot produces a total of 147 tomatoes.

1. On the Calculator entry line, type 1.7  4.2, and press .

1.7·4.2	7.14
---------	------

2. Type 147  *ans*, and press  to find the yield.

147	20.5882
7.14	

As a second example, calculate $\frac{3.76}{-7.9+\sqrt{5}}$ and then add $2 \cdot \log(45)$.

3. Type $3.76 \left(\frac{\square}{\square} \right) \left(\left(\frac{\square}{\square} \right) 7.9 + \text{sqrt}(5) \right)$, and press $\left(\frac{\square}{\square} \right)$.

3.76	-0.66385
$-7.9+\sqrt{5}$	

4. Type $\text{ans}+2 \left(\frac{\square}{\square} \right) \log(45)$, and press $\left(\frac{\square}{\square} \right)$.

$-0.66384977522033+2 \cdot \log_{10}(45)$	2.64258
---	---------

Temporarily substituting a value for a variable

Use the “|” (such that) operator to assign a value to a variable for just a single execution of the expression.

$a:=200.12$	200.12
$a^2 a=100$	10000
a	200.12

Creating user-defined functions and programs

You can use the **Define** command to create your own functions and programs. You can create them in the Calculator application or in the Program Editor and then use them in other TI-Nspire™ applications.

For information on programming with the Program Editor, see the “Programming” and “Libraries” sections of the documentation.

Defining a single-line function

Suppose you want to define a function named **cube()** that calculates the cube of a number or variable.

- On the Calculator entry line, type `Define cube(x)=x^3` and press $\left(\frac{\square}{\square} \right)$.

Define $\text{cube}(x)=x^3$

Done

The message "Done" confirms that the function has been defined.

2. Type `cube(2)` and press  to test the function.

`cube(2)`


8

Defining a multiple-line function using templates


You can define a function consisting of multiple statements entered on separate lines. A multiple-line function may be easier to read than one with multiple statements separated by colons.

Note: You can create multiple-line functions only by using the **Define** command. You cannot use the `:=` or `→` operators to create multiple-line definitions. The **Func...EndFunc** template serves as a container for the statements.


As an example, define a function named $\mathbf{g}(x,y)$ that compares two arguments x and y . If argument $x >$ argument y , the function should return the value of x . Otherwise, it should return the value of y .

1. On the Calculator entry line, type `Define g(x,y)=`. Do not press  yet.

`define g(x,y)=`

2. Press  to display the Calculator menu.
3. On the **Functions & Programs** menu, select **Func...EndFunc**.
Calculator inserts the template.

`define g(x,y)=Func`
|
...|
EndFunc

4. Press  to display the Calculator menu.
5. On the **Functions & Programs** menu, select **Control**, and then select **If...Then...Else...EndIf**.
Calculator inserts the template.

```

define g(x,y)=Func
    If | Then
    Else
    EndIf
EndFunc


```

6. Type the remaining parts of the function, using the arrow keys to move the cursor from line to line.

```

define g(x,y)=Func
    If x>y Then
        return x
    Else
        return y|
    EndIf
EndFunc

```

7. Press  to complete the definition.
 8. Evaluate $g(3, -7)$ to test the function.



```


g(3,-7) 3

```

Defining a multiple-line function manually

Note: To start each new line without completing the function definition, you press  instead of pressing .


As an example, define a function **cum_sum(x)** that calculates the cumulative sum of integers from 1 through x . You can type the underscore symbol by pressing  .

1. On the Calculator entry line, type `Define cum_sum(x)=`. Do not press  yet.

```

Define cum_sum(x)=|

```

2. Press  to display the Calculator menu.
 3. On the **Functions & Programs** menu, select **Func...EndFunc**.
 Calculator inserts the template.

```
Define cum_sum(x)=Func
    ...
EndFunc
```

4. Type the following lines, pressing \ominus at the end of each line.

```
Define cum_sum(x)=Func
    Local i,tmpsum
    tmpsum:=0
    For i,1,x
        tmpsum:=tmpsum+i
    EndFor
    Return tmpsum
EndFunc
```

5. After typing `Return tmpsum`, press enter to complete the definition.
6. Evaluate `cum_sum(5)` to test the function.

```
cum_sum(5) 15
```

Defining a program

Defining a program is similar to defining a multiple-line function. The **Prgm...EndPrgm** template serves as a container for the program statements.


As an example, create a program named **g(x,y)** that compares two arguments. Based on the comparison, the program should display the text “*x* greater than *y*” or “*x* not greater than *y*” (showing the values of *x* and *y* in the text).

1. On the Calculator entry line, type `Define prog1(x,y)=`. Do not press enter yet.

```
Define prog1(x,y)=
```

2. Press menu to display the Calculator menu.
3. On the **Functions & Programs** menu, select **Prgm...EndPrgm**.
Calculator inserts the template.

```
Define prog1(x,y)=Prgm
    |
    EndPrgm
```


- Press  to display the Calculator menu.
- On the **Functions & Programs** menu, select **Control**, and then select **If...Then...Else...EndIf**.

Calculator inserts the template.


```
Define prog1(x,y)=Prgm
    If | Then
    Else
    EndIf
    EndPrgm
```

- Type the remaining parts of the function, using the arrow keys to move the cursor from line to line. Use the Symbol Palette to type the " \leq " symbol.

```
Define prog1(x,y)=Prgm
    If x>y Then
        Disp x," > ",y
    Else
        Disp x," ≤ ",y|
    EndIf
    EndPrgm
```

- Press  to complete the definition.
- Execute `prog1(3,-7)` to test the program.

```
prog1(3,-7)
3 > -7
Done
```

- Note:** To stop a program or function manually, hold down the  key for several seconds.

Recalling a function or program definition

You might want to reuse or modify a function or program that you have defined.

1. Press  to display the Calculator menu.

2. On the **Actions** menu, select **Recall Definition**.

A dialog box appears with a list of defined functions and programs.


3. Select the name from the list.

The definition (for example, `Define f(x)=1/x+3`) is pasted into the entry line for editing.





Editing Calculator expressions

Although you cannot edit an expression in the Calculator history, you can copy all or part of an expression from the history and paste it to the entry line. You can then edit the entry line.

Positioning the cursor in an expression

► Press  to cycle through the parameters of a template.

– or –

Press , , , or  to move the cursor through the expression. The cursor moves to the closest valid position in the direction that you press.

Note: An expression template may force the cursor to move through its parameters, even though some parameters may not be exactly in the path of the cursor movement. For example, moving upward from the main argument of an integral always moves the cursor to the top limit.

Inserting into an expression in the entry line

1. Position the cursor at the point where you want to insert additional elements.

2. Type the elements that you want to insert.

Note: When you insert an open parenthesis, Calculator adds a temporary close parenthesis, displayed in gray. You can override the temporary parenthesis by typing the same parenthesis manually or by entering something past the temporary parenthesis (thereby implicitly validating its position in the expression). After you override the temporary gray parenthesis, it is replaced with a black parenthesis.

Selecting part of an expression

1. Press \leftarrow , \rightarrow , \uparrow , or \downarrow to move the cursor to a starting point.
2. Press and hold CAPS and press \leftarrow , \rightarrow , \uparrow , or \downarrow to select.

Deleting all or part of an expression on the entry line

1. Select the part of the expression to delete.
2. Press clear .

Financial calculations

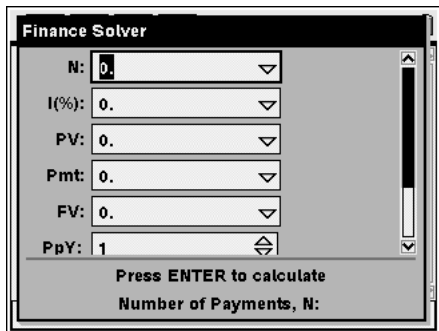
Several TI-Nspire™ CAS functions provide financial calculations, such as time value of money, amortization calculations, and return on investment calculations.

The Calculator application also includes a Finance Solver. It lets you dynamically solve several types of problems, such as loans and investments.

Using the Finance Solver

1. Press menu to display the Calculator menu.
2. On the **Algebra** menu, select **Finance Solver**.

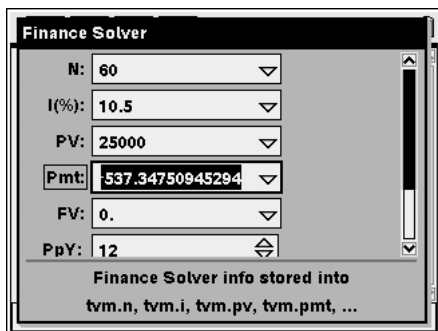
The solver displays its default values (or previous values, if you have already used the solver in the current problem).



3. Enter each known value, using tab to cycle through the items.
 - The help information at the bottom of the solver describes each item.
 - You might need to temporarily skip the value that you want to calculate.

- Make sure to set **PpY**, **CpY**, and **PmtAt** to the correct settings (12, 12, and END in this example).
4. Press $\boxed{\text{tab}}$ as necessary to select the item that you want to calculate, and then press $\boxed{\text{enter}}$.

The solver calculates the value and stores all the values in "tvm." variables, such as *tvm.n* and *tvm.pmt*. These variables are accessible to all TI-Nspire™ CAS applications within the same problem.



Finance functions included

In addition to the Finance Solver, TI-Nspire™ CAS built-in finance functions include:

- TVM functions for calculating future value, present value, number of payments, interest rate, and payment amount.
- Amortization information such as amortization tables, balance, sum of interest payments, and sum of principal payments.
- Net present value, internal rate of return, and modified rate of return.
- Conversions between nominal and effective interest rates, and calculation of days between dates.

Notes:

- Finance functions do not automatically store their argument values or results to the TVM variables.
- For a complete list of TI-Nspire™ functions, refer to the Reference Guide.

Working with the Calculator history

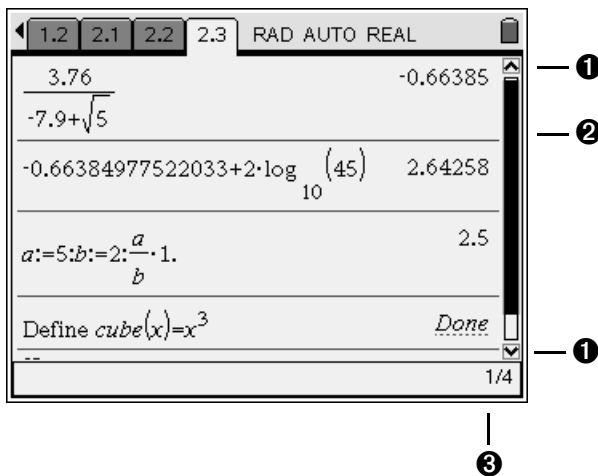
As you enter and evaluate expressions in the Calculator application, each entry/result pair is saved in the Calculator history. The history gives you a way to review your calculations, repeat a set of calculations, and copy expressions for reuse in other pages or documents.

Viewing the Calculator history

The history of the expressions you have entered accumulates above the entry line, with the most recent expression at the bottom. If the history does not fit in the Calculator work area, you can scroll through the history.

Note: You may notice a processing slowdown when the history contains a large number of entries.

- Press ▲ or ▼.



- 1 Scrollbar buttons
- 2 Scroll position indicator
- 3 Current entry/total entries



Reusing a previous expression or result

You can copy an expression, subexpression, or result from the Calculator history and paste it into the entry line or into other TI-Nspire™ applications.

1. Scroll to the item that you want to copy.
2. Select the item.

approx	$\frac{2^8 \cdot 12}{42}$	73.1428571429
--------	---------------------------	---------------

Note: The float setting for the current document may limit the number of decimal places displayed in a result. To capture the result in its full precision, select it either by scrolling with the up and down arrow keys or by triple-clicking it.

3. Press  **C** to make the copy.
4. Select the location where you want the copy.
5. Press  **V** to paste the copy.

$\sqrt{\frac{2^8 \cdot 12}{42}}$	$\frac{16 \cdot \sqrt{14}}{7}$
----------------------------------	--------------------------------


Note: If you copy an expression that uses variables into a different problem, the values of those variables are not copied. You must define the variables in the problem where you paste the expression.

Deleting an expression from the history

When you delete an expression, all variables and functions defined in the expression retain their current values.

1. Use the arrow keys to select the expression that you want to delete.


$\sqrt{\frac{2^8 \cdot 12}{42}}$	$\frac{16 \cdot \sqrt{14}}{7}$
----------------------------------	--------------------------------

2. Press .

The expression and its result are removed.

Clearing the Calculator history

When you clear the history, all variables and functions defined in the history retain their current values. If you clear the history by mistake, use the undo feature.

1. Press  to display the Calculator menu.
2. On the **Actions** menu, select **Clear History**.

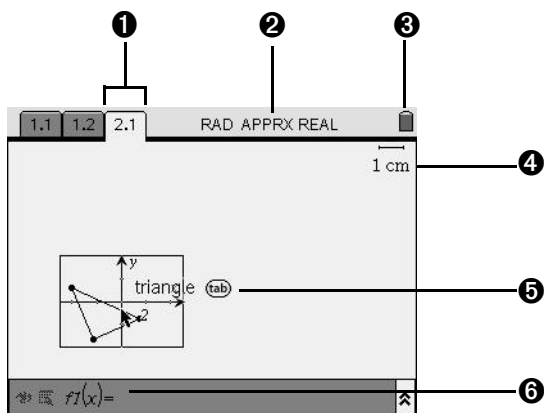
All expressions and results are removed from the history.

Using Graphs & Geometry

Getting started with Graphs & Geometry

The Graphs & Geometry application enables you to:

- Graph and explore functions.
- Create and explore geometric shapes.
- Animate points on objects or graphs and explore their behavior.
- Graph data collected by the Data Collection tool.
- Explore graphical and geometric transformations.
- Explore and investigate concepts of calculus.
- Link to data created by other applications and utilize it in Graphs & Geometry.



- 1 Problem/Page number counter
- 2 System Settings indicator
- 3 Status indicator (with battery status indicator)
- 4 Graphs & Geometry units indicator (sample display is centimeters)
- 5 Sample Graphs & Geometry work area in Graphing View, with Analytic Window and tooltip for triangle shown
- 6 Sample Graphs & Geometry entry line (line for function entry shown)

Getting acquainted with Graphs & Geometry


- ▶ Turn on the TI-Nspire™ handheld, and add the Graphs & Geometry application to your page.

When you add Graphs & Geometry to a page, your work area contains the x and y axes for a graph, as well as a function entry line and Graphs & Geometry-specific tools.




The basic components of the Graphs & Geometry application are the:





- Tool menu
- Work area (which contains the axes)
- Entry line.







The Tool menu

Press  to open the **Actions** menu. These menus and tools enable you to graph and explore different types of functions, draw and explore geometric structures, as well as other capabilities which will be covered in this chapter.






The following tables contain a brief summary of what each menu contains or tool enables you to do within the Graphs & Geometry work area.






Note: The number that precedes each title is the numeric entry for accessing the tool using the handheld keys or the virtual keypad on the computer. For example, to draw a circle, you would press   .

Menu Option List	Overview of Tool Actions
 1: Actions	Provides tools to access the pointer, hide or show various graph features, add text, delete all objects in the work area, access the calculate tool, and access the attributes for an object or function.
 2: View	Provides tools to manipulate the work area features and display.
 3: Graph Type	Enables you to select the type of graph to plot in the work area: function, parametric, polar, or scatter plot. The entry line below the work area shows the notational conventions to use to specify a function for the selected graph type.
 4: Window	Provides different Zoom settings as well as the ability to define the x - and y -axis minimums and maximums.


Menu Option List	Overview of Tool Actions
 5: Trace	Creates and activates a trace on the graph. Sets the trace increment and enables you to create and remove geometric trace.
 6: Points & Lines	Provides tools for drawing various types of points, lines, segments, rays, tangents, vectors, and circle arcs.
 7: Measurement	Provides tools for measuring angles, lengths, areas, integrals, and slope.
 8: Shapes	Provides tools for drawing circles, triangles, rectangles, and polygons.
 9: Construction	Provides tools to define perpendicular and parallel lines, bisectors, midpoints, locus, compass, and perform measurement transfers.
 A: Transformation	Provides tools for symmetry, reflection, translation, rotation, and dilation.






Action Menu Tools

Tool name	Tool function
 1: Pointer	Selects, moves, and manipulates objects.
 2: Select	Enables you to select the objects in part of the work area by placing a dashed-line box around them.
 3: Hide/Show	Enables you to hide or display any object, function, or feature on the work area.
 4: Attributes	Enables you to change the attributes of a selected object in the work area. Attributes vary depending upon the object selected.
 5: Delete All	Removes all objects and graphed functions from the page.



Tool name	Tool function
 6: Text	Places user-created alpha-numeric values on the page. Numerical values can be applied to objects. The tool can be used to enter a function and graph it.
 7: Coordinates and Equations	Displays the coordinates of a point or the equation of a line or circle.
 8: Calculate	Opens the calculate tool to perform calculations using measurements, numerical values, or calculation results. This tool is different from the Calculator application.
 9: Redefine	Redefines a previously defined point to a new location. For example, it can define a point in free space to a location on an object or from one object to another object.
 A: Insert Slider	Lets you easily modify the value of a numeric variable.



View Menu Tools

Tool name	Tool function
1: Graphing View	Places the work area in graphing mode. When you add Graphs & Geometry to a page the Cartesian axes displays in the work area with a function entry line below.
2: Plane Geometry View	Places the work area in geometry mode. Geometry scale displays, but no axes, grid, or entry line displays until you choose Show Analytic Window.
 3: Hide (Show) Analytic Window	Opens a small graphing window on a plane geometry work area. Places the Graphs & Geometry work area in modeling mode. This tool can be used only after Plane Geometry is selected.







Tool name	Tool function
 4: Hide (Show) Axes	Hides the axes if they are currently displayed on the page. Displays the axes if none are displayed on the page.
 5: Show (Hide) Grid	Turns the grid on or off on the page. Objects can be attached to the grid when the grid is displayed.
 6: Hide (Show) Entry Line	Hides or displays the entry line on the page.
 7: Show (Hide) Scale	Toggles between showing and hiding the scale legend on the work area. When the scale is shown, the value and/or units can be changed to desired values/units. This applies only to geometric constructions.
Show (Hide) Axes End Value	Toggles between showing and hiding the lowest value and highest value on the horizontal and vertical axes.
 8: Add Function Table	Launches the Lists & Spreadsheet function table. When launched from Graphs & Geometry, it is pre-populated with all functions defined in the problem with the exception of hidden functions. More information on using Function Tables is available in the Lists & Spreadsheet chapter of this document.






Graphing Type Menu Tools

Tool name	Tool function
 1: Function	Displays the function mode entry line at the bottom of the work area.
 2: Parametric	Displays the parametric mode entry line at the bottom of the work area. This display shows the t-min, t-max, and t-step values. The defaults are $0-2\pi$ for t-min, t-max, and $\pi/24$ for t-step.




Tool name	Tool function
 3: Polar	Displays the Polar mode entry line at the bottom of the work area. This display shows the θ -min, θ -max, and θ -step values. The defaults are $0-2\pi$ for θ -min and θ -max, and $\pi/24$ for θ -step.
 4: Scatter Plot	Displays the Scatter Plot mode entry line at the bottom of the work area.


Window Menu Tools

Tool name	Tool function
 1: Window Settings	Lets you specify the minimum and maximum values for the x-axis and y-axis. You can also set the axis scaling increment between tics.
 2: Zoom - Box	Enables you to define an area that you want to enlarge.
 3: Zoom - In	Enables you to define the center point of the zoom in location. The Zoom In factor is approximately 2.
 4: Zoom - Out	Enables you to define the center point of the zoom out location. The Zoom Out factor is approximately 2.
 5: Zoom - Standard	Automatically sets x-min, x-max, y-min, and y-max to center the origin. The x and y scale factors are equal. This is the default axes setting when Graphs & Geometry is first added to a page.
 6: Zoom - Quadrant 1	Automatically sets x-min, x-max, y-min, and y-max to emphasize the first quadrant. The x and y scale factors are equal.












	Tool name	Tool function
	7: Zoom - User	If you have modified any window settings (such as x-min), Zoom-User saves the present settings. If you have not modified any window settings since last selecting Zoom-User, Zoom-User restores those settings.
	8: Zoom - Trig	Automatically sets x-min and x-max to integer multiples of π . The x and y scale factors are equal.
	9: Zoom - Data	Redefines the axes so that all statistical data points are displayed.
	A: Zoom - Fit	Recalculates y-min and y-max to include the minimum and maximum y values of all functions between the current x-min and x-max. Hidden functions are not included.
	B: Zoom - Square	Recalculates y-min and y-max so that the vertical scale is the same as the horizontal scale.

Trace Menu Tools






	Tool name	Tool function
	1: Graph Trace	Activates a trace point on the graph, enabling you to trace functions.
	2: Trace Setting	Enables you to set the increment between points touched by Graph Trace automatically, or by specifying a numeric trace step value.
	3: Geometry Trace	Enables you to view the pathway of a geometric or analytic object (such as a function graph) on the work area. The pathway has a delayed fade. As more movement occurs on the work area, older portions of the pathway fade. If you temporarily halt movement, a portion of the trace path remains displayed.

Tool name	Tool function
 4: Erase Geometry Trace	Halts geometric trace and erases all persistent pathways on the work area.







Points and Lines Menu Tools

Tool name	Tool function
 1: Point	Constructs a point defined in free space, on an object, or at the intersection of two objects.
 2: Point On	Constructs a point defined on an object. When the object is a function graph, the coordinates are displayed.
 3: Intersection Point(s)	Constructs a point at each intersection of two selected objects.
 4: Line	Constructs an infinite line defined by two points or by a point and a direction. If you press  while creating the line, you limit its orientation, relative to the x-axis or the horizontal aspect of the screen, by 15° increments.
 5: Segment	Constructs a segment, defined by two end points, which may be created or defined in free space or on a defined object.
 6: Ray	Constructs a ray, defined by two points or by a point and a direction, extending infinitely. If you press  while creating the ray, you limit its orientation, relative to the x-axis or the horizontal aspect of the screen, by 15° increments.
 7: Tangent	Creates a tangent line.
 8: Vector	Constructs a vector with magnitude and direction defined by two points.
 9: Circle arc	Creates an arc based on three points.









Measurement Menu Tools

Tool name	Tool function
 1: Length	Displays the distance between two selected points or the length of a segment, perimeter, circumference, or radius.
 2: Area	Displays the area of a selected polygon or circle.
 3: Slope	Displays the slope of a selected line or segment. A vertical slope is represented by ∞ .
 4: Angle	Displays the measure of an angle or an angle defined by three selected points.
 5: Integral	Calculates and displays the numerical value of the integral of a selected function, and shades the area between the curve and the x-axis from point a to point b.


Shapes Menu Tools





Tool name	Tool function
 1: Circle	Constructs a circle. The center point is defined by the first click on the page and the radius is determined by the second click.
 2: Triangle	Constructs a triangle, defined by three points (vertices), which may be created or defined in free space or on a defined object.
 3: Rectangle	Constructs a rectangle.
 4: Polygon	Constructs an n -sided polygon. Each click defines a vertex, and the polygon is completed by clicking the initial vertex or by pressing  .
 5: Regular Polygon	Constructs an n -sided regular polygon.

Construction Menu Tools

Tool name	Tool function
 1: Perpendicular	Constructs a line perpendicular to a selected line, segment, ray, vector, axis, or side of a polygon, and passing through a created or selected point.
 2: Parallel	Constructs a line parallel to a selected line, segment, ray, vector, axis, or side of a polygon, and passing through a created or selected point.
 3: Perpendicular Bisector	Constructs a perpendicular line that bisects two points, a segment, or side of a polygon.
 4: Angle Bisector	Constructs a line that bisects an angle identified by three selected points where the second point is the vertex.
 5: Midpoint	Constructs a midpoint of two selected points, a segment, or side of a polygon.
 6: Locus	Constructs the locus of a point or object defined by the movement of a driver point along a pathway. Pathways are geometric shapes and function graphs.
 7: Compass	Constructs a circle from a center point with a radius defined by a selected segment or the distance between two points.
 8: Measurement transfer	Transfers an entered or measured value to a selected object, axis, or function graph. If the original value changes, the change is also reflected in the transferred measurement.

Transformation Menu Tools

Tool name	Tool function
 1: Symmetry	Creates the image of an object rotated 180° around a point.

Tool name	Tool function
 2: Reflection	Creates the image of an object reflected across a line, segment, ray, vector, axis, or side of a polygon.
 3: Translation	Creates the image of an object translated by a specified vector.
 4: Rotation	Creates the image of an object rotated around a point by a specified angular value.
 5: Dilation	Creates the image of an object dilated from a point by a specified factor.

Note: When you select a tool to use, that tool's icon displays in the upper left corner of the Graphs & Geometry page. It is there to remind you which tool is currently active.

Using the context menu

The context menu provides the tools most commonly used with the selected object, function, or axes.

To display the context menu for an object:

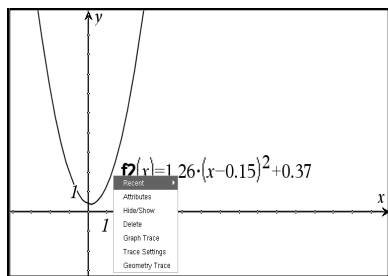
- ▶ Move the cursor to the object and then press  .

The first two options on the context menu are:

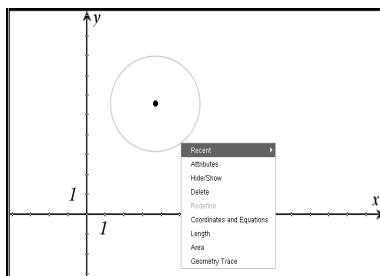
- **Recent:** lists the 9 most recent tools you used. This is a session-level listing. The tools used on any Graphs & Geometry page are shown, regardless of the document in which they are used.
- **Attributes:** enables you to access the attributes appropriate for a selected function, object, or work area.

Additional options that are appropriate for your selection also display on the menu. For example, the context menu for a triangle also contains the Hide/Show, Delete, Length, and Area options.

The following examples show the context menu for a function and a circle.



Context menu for a function (analytic object)



Context menu for a geometric object

The work area

There are two work area views available:

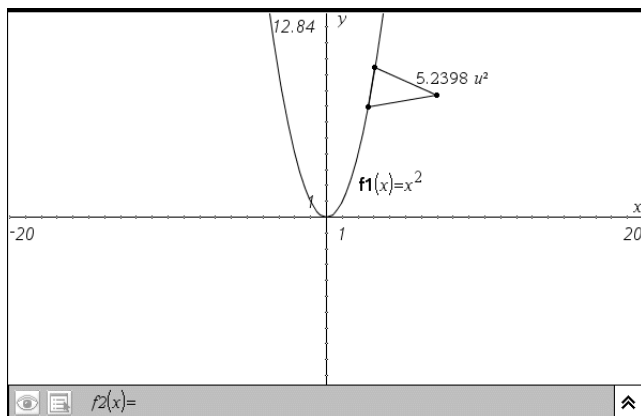
- Graphing View
- Plane Geometry View

The Graphing view

The Graphing view is the default Graphs & Geometry work area display. It contains:

- the default Cartesian axes in the Zoom Standard format (1:1 scale).
- the entry line from which you can graph up to 100 functions.

Axes, entry line, and grid can all be displayed or hidden, but in this view, no scale for any drawn shapes (e.g. Circle, etc.) can be displayed. All objects created in this view are analytic objects. Therefore, their displayed size and proportion are affected only by the scale of the axis system (the command "Show Scale" has no effect).



The Plane Geometry view

The plane geometry view removes the axes and entry line from the work area to enable you to draw geometric shapes and explore them. In this view, you can display and set a scale for your drawings.

To change to Plane Geometry view:

1. From the **View** menu, select **Plane Geometry View**.

Press (menu) (2) (2) .

2. The display refreshes to clear the axes and entry line and display a default scale. Any graphs or drawings created in graphing view are not displayed on the plane geometry area.

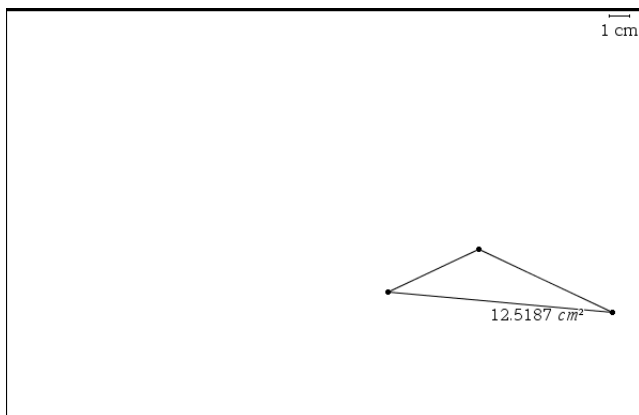
To return to Graphing view:

- From the **View** Menu, select **Graphing View**.

Press (menu) (2) (1) .

The display refreshes to show the axes and entry line.


Note: Any geometric constructions created while in the plane geometry view are retained and displayed along with any previously-created graphs.






The analytic window

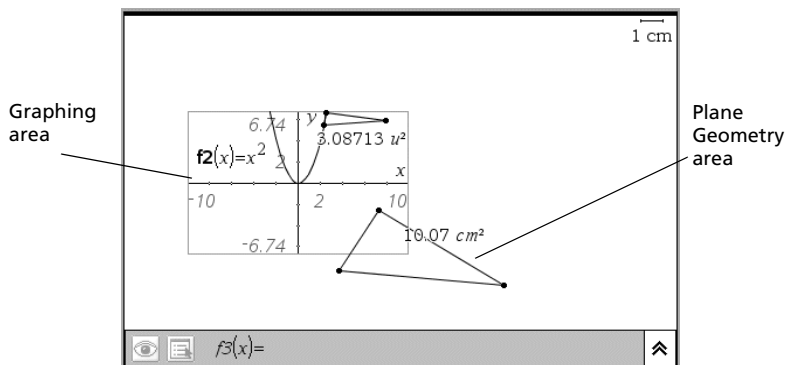
The analytic (graphing) window is available in the Plane Geometry view. It adds an analytic (graphing) window on top of a portion of the plane geometry work area. This provides a combination work area that enables you to use both work area types without toggling the view between them.

To open the analytic window:

1. Ensure that the work area is in Plane Geometry view.
2. From the **View** menu, select **Show Analytic Window** .

Press   .

3. A reduced size graphing window opens on the lower left corner of the plane geometry space.



Modeling view - shows the previous two views and the work done on both.




You can alter the work area, without changing the view, to temporarily:

- Hide the axes. Any graphs or objects remain displayed on the work area.
- Show or hide axis end values and show or hide a grid in the graphing window.
- Hide the entry line.
- Hide the scale.
- Resize the axes using the zoom tools or by dragging tic marks.

To display more of the plane geometry work area, pan the screen.

To remove the analytic window from the work area

1. From the **View** menu, select **Hide Analytic Window** .

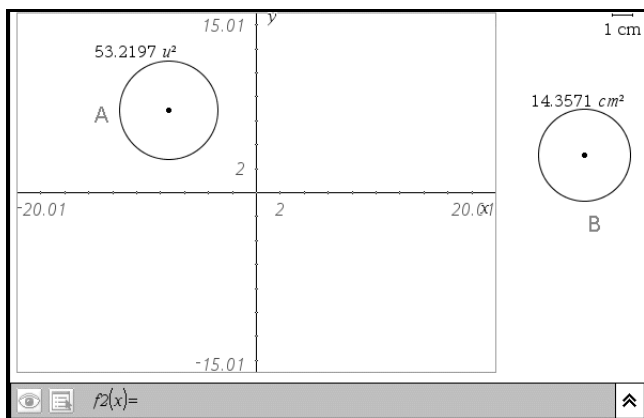
Press   .

Object behavior in different views

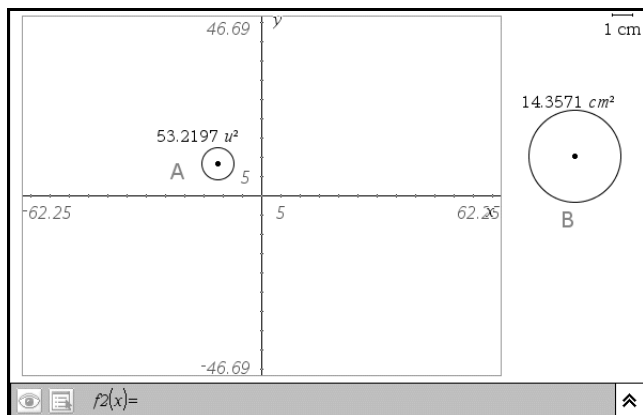
When you create an object in the graph area, it is called an analytic object, and all points of the object reside on the graph plane. When you change the axes scale, you automatically affect the appearance of the object. If you calculate a value associated with the object such as the area, only generic units are assigned (**u** for unit). These objects remain associated with the coordinate plane until you delete them or redefine them to the plane geometry area. When working with a modeling view work area, you cannot move an analytic object onto the plane geometry area.

When you create an object in the plane geometry area, it is a geometric object. These objects can have an assigned scale, such as miles or centimeters, instead of u for units. You can lock a point, such as one vertex of a triangle, on the work area, but since the object is not tied to a coordinate plane, you cannot display coordinates for that vertex. When working with a modeling mode work area (Plane Geometry view with analytic window), you can move a geometric object into the graphing work area. The object remains a geometric object, and is not associated with the axes.

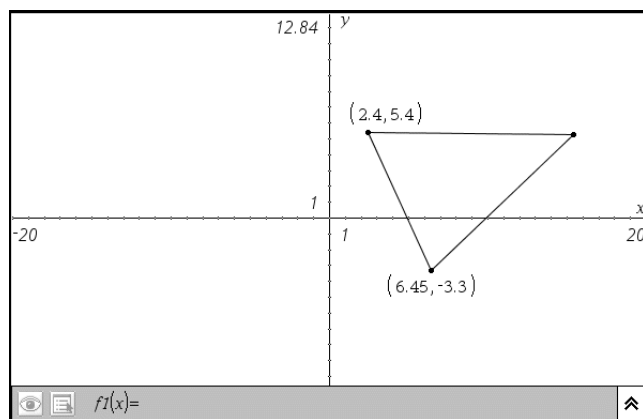
The examples below show a modeling work area and the two types of objects: A is an analytic object while B is a geometric object.



While the two circles appear identical, they do not behave in the same way. Analytic objects are impacted when the graph area is altered. In the next example, the axes were altered. Notice that only Circle A's appearance is affected by the change.



If you construct an object while the axis is hidden, the object created will be a geometric object. However, if you construct an analytic object and later hide the axis, the object remains an analytical one.



Triangle as it appears in Graphing view. The unlabeled vertex remains a geometric point.

Summary of differences

Feature	Graph Area	Plane Geometry Area
Aspect Ratio	Adjustable; initially 1:1	Always 1:1 (static)
Units of Measure	Generic (displayed as u)	User-defined (per scale)
Area Graph Type	Cartesian (default) or Polar	Euclidian
Uses	<ul style="list-style-type: none">• Define and graph functions to:<ul style="list-style-type: none">– Graph functions of the form $f(x)$– Create scatter plots– Graph polar equations– Graph parametric functions• Construct analytic objects• Label equations• Identify coordinates for discrete points	<ul style="list-style-type: none">• Construct Euclidean objects• Create transformations• Determine measurements (for example, length, angle, or area)
Behavior	Analytic constructions must remain in the analytic area.	Geometric constructions can be moved into the analytic area but remain geometric in nature.

Creating and manipulating axes

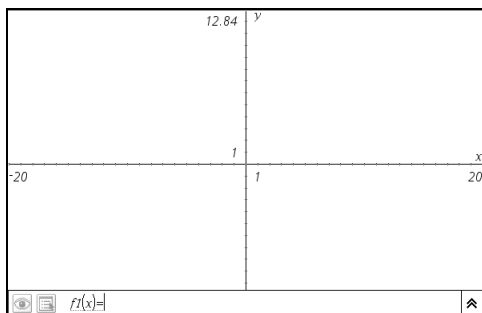
When you add the Graphs & Geometry application to a page, Cartesian axes displays by default.

You can change the appearance of your axes in the following ways:

1. Adjust the length of the axes:
 - When using Plane Geometry view with Show Analytic Window,
 - Select an axis and retype the domain or range labels.

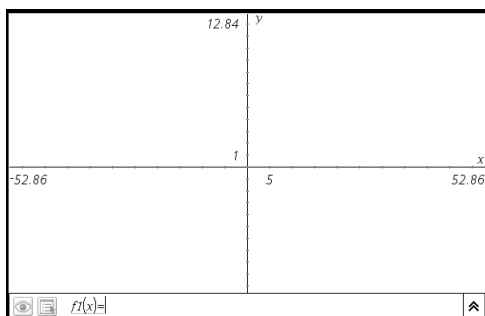
- Select an axis and drag to increase or decrease the numbers on the scale and tic mark spacing.

The aspect ratio of the axes is retained. To modify the scale of only one axis, press $\left(\begin{smallmatrix} \text{SPACE} \\ \updownarrow \end{smallmatrix}\right)$ as you adjust the value or drag the line.




Default range and domain

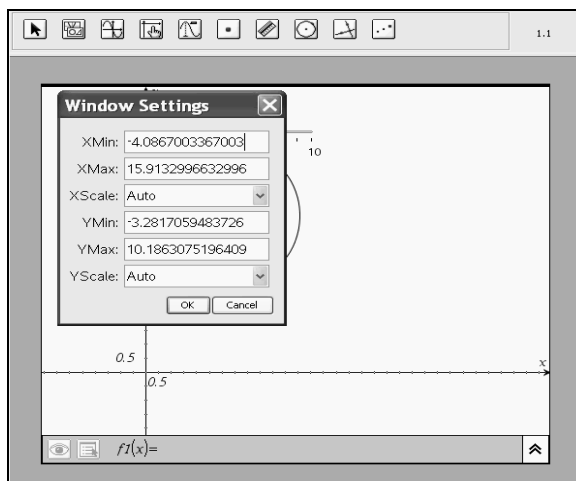
Extended domain



- Use the Zoom tool options to adjust the view.
- Adjust the end style of the axes using the Attributes tool. Display the Attributes tool by:
 - selecting it from the menu or
 - pressing $\left(\text{ctrl}\right)$ and clicking an axis between two tick marks.


Press the left and right arrow keys to display the desired end style. The attributes list for the axes also enables you to select a Zoom tool.
- Adjust the axes scale and tic mark spacing manually.
 - Click and hold one tic mark, and move it on the axis. The spacing and number of tic marks increases (or decreases) on both axes.
 - To adjust the scale and tic mark spacing on a single axis, press and hold $\left(\begin{smallmatrix} \text{SPACE} \\ \updownarrow \end{smallmatrix}\right)$, and then grab and drag a tic mark on that axis.




- Change axis end values by double-clicking them and typing new values.
- Adjust the location of the axes. To move the existing axes without resizing or rescaling them, click in and drag an empty region of the screen until the axes are in the desired location.
- Use the Window Setting tool  to define the x-max, x-min, y-max, y-min, x-scale and y-scale values for the axes. When selected, this tool opens a dialog that enables you to enter the values desired. The current values are initially displayed. Type over them to enter new values.



Window Settings dialog with initial values displayed

Note: The axis values set on the Window Settings dialog can be stored as variables that can be accessed outside of Graphs & Geometry. Select the axis label at the value to be linked, and then click **var** to link to the value. You can use tools on the **View** menu to hide and redisplay the axes, the scale, and axis end values.

- From the **View** menu, select **Hide/Show Axes** .

Press   .

- If the axes are shown on the page, selecting this tool hides them.
- If the axes are hidden on the page, selecting this tool redisplay them.

Moving about the work area


Graphs of functions may extend beyond the visible portion of your screen. This does not mean they are truncated. You can view them by panning the screen. To pan the screen:




1. Click and hold the mouse button in an open area of the page.
2. Move to display different portions of the screen.

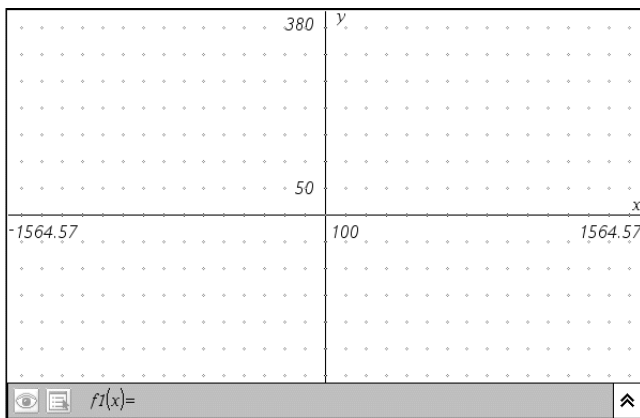
Turning the grid on or off

Graphs & Geometry can display a grid in addition to the axes for a function. You control the sizing of the grid as well as whether or not it is visible.

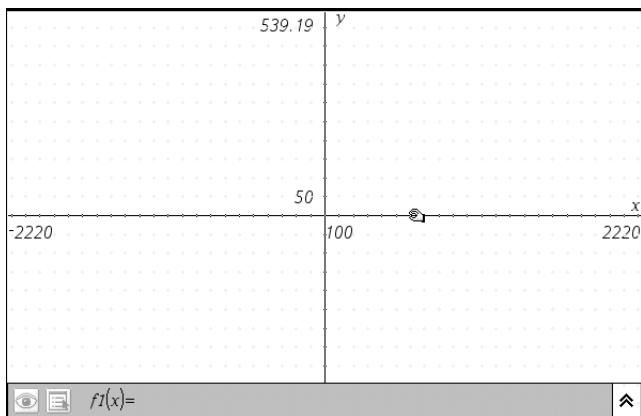
To display the grid:

- From the **View** menu, select **Show Grid** .

Press   .



You resize the grid by rescaling the axes.



To turn the grid off:

- From the **View** menu, select the **Hide Grid**

Press .

When the tool is selected, the page updates to remove the grid.

In addition, you can attach a function, graph, or object to the grid while the grid is displayed.

Attaching an object to the grid

1. Display the grid on the page if it is not already present.
2. Draw an object on the grid. Positioning the object so that points coincide with grid marks attaches the object to the grid.

For example, if you draw a triangle, then one or more of the vertices must coincide with grid marks.

Note: You do not have to attach an object or graph to the grid. When you attach an object to the grid, its subsequent relocation is constrained to other grid points. Analytic objects are affected by axes changes regardless of whether or not they are attached to the grid.

To unattach an object from the grid, select and redefine it so that points do not coincide with grid marks. If you hide the grid, objects attached to it remain displayed on the page and remain attached to the grid even though it is no longer visible.

The Zoom feature

For screens with many function graphs, it can be difficult to view intersections and other areas of interest. To temporarily change your view of the screen, use the Zoom feature.

To use Zoom:

1. Open the **Window** menu.

Press $\text{\textcircled{menu}}$ $\text{\textcircled{4}}$.

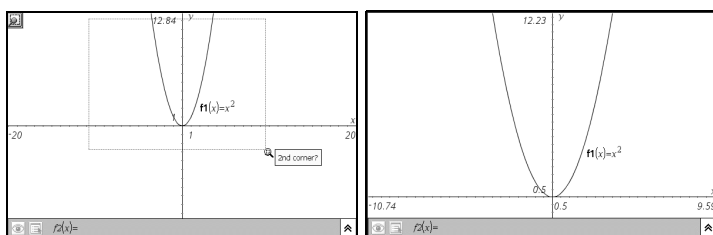
2. Click the Zoom tool you want to use.

In the following examples, all options except Zoom-Fit started with the graph of x^2 . Zoom-Fit shows a graph of a sine function.

The options are:

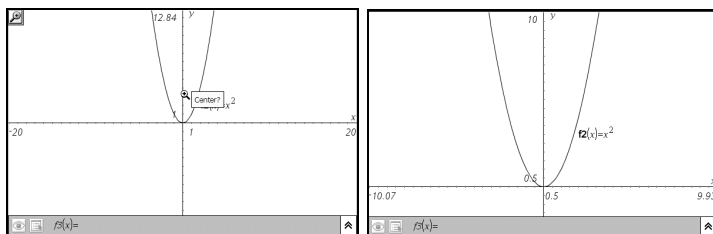
- Zoom - Box

Press $\text{\textcircled{menu}}$ $\text{\textcircled{4}}$ $\text{\textcircled{2}}$.



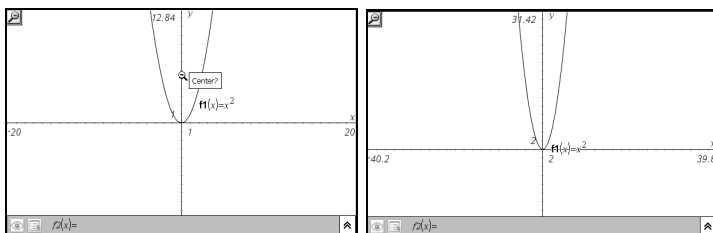
- Zoom - In

Press $\text{\textcircled{menu}}$ $\text{\textcircled{4}}$ $\text{\textcircled{3}}$.



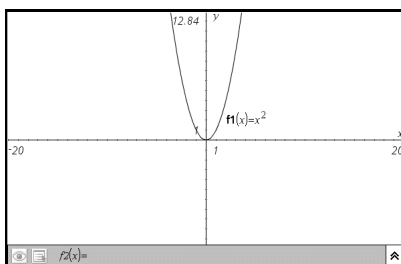
- Zoom - Out

Press $\text{\textcircled{menu}}$ $\text{\textcircled{4}}$ $\text{\textcircled{4}}$.



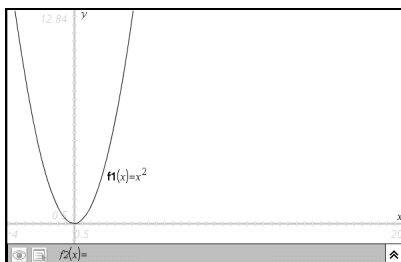
- Zoom - Standard

Press menu $\langle 4 \rangle$ $\langle 5 \rangle$.



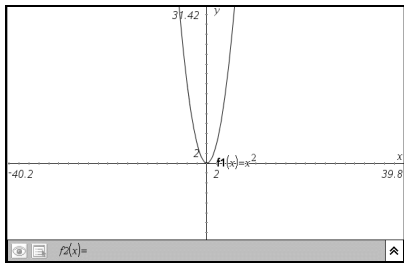
- Zoom - Quadrant 1

Press menu $\langle 4 \rangle$ $\langle 6 \rangle$.



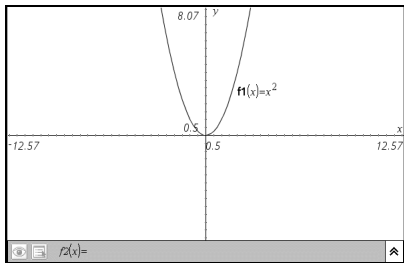
- Zoom - User (appears the same as Zoom - Standard if no new configuration is saved)

Press menu $\langle 4 \rangle$ $\langle 7 \rangle$.



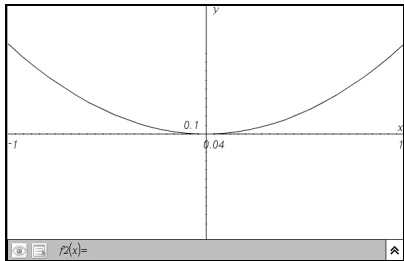
- Zoom - Trig

Press **(menu)** **4** **8**.



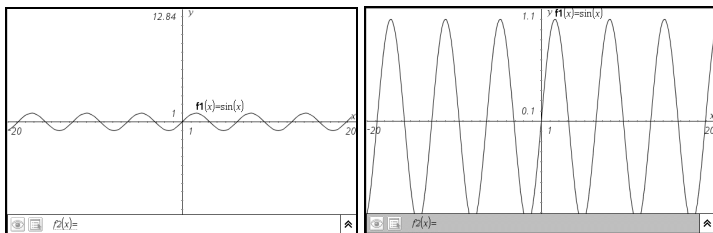
- Zoom - Data

Press **(menu)** **4** **9**.



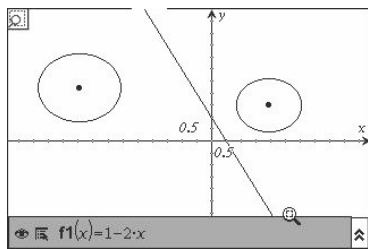
- Zoom - Fit

Press **(menu)** **4** **(A)**.

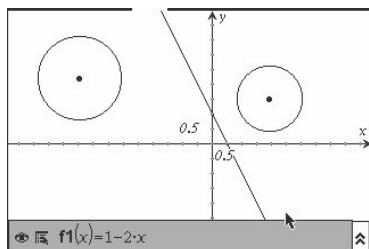


- Zoom - Square

Press .



Circles before Zoom - Square



Circles after Zoom - Square

3. The graph displays in the selected zoom view.

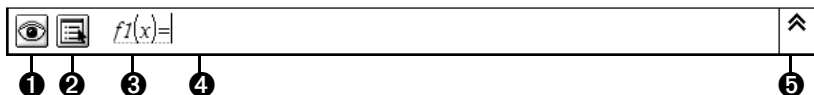
If you select **Zoom Box**, you must click the first and third corners of the box.

If you select either **Zoom In** or **Zoom Out**, you must click the center point before the graph is redrawn.

4. To return the graph to its initial state, either select **Undo** or select **Zoom - Standard** from the **Zoom** menu.

The entry line

The Entry line appears at the bottom of the Graphs & Geometry work area. When the line is not active, it is grayed out.



From left to right, the parts of this line are:

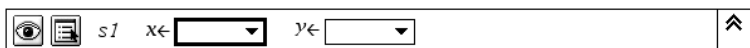
- 1 Hide/Show button.
- 2 Attributes button.

- 3 $f_1(x)=$ is the default notation for a function or inequality.
- 4 Blank area into which you enter the function, polar equation, inequality, parametric, or scatter plot data to be graphed.
- 5 Expand/Contract (History) button.



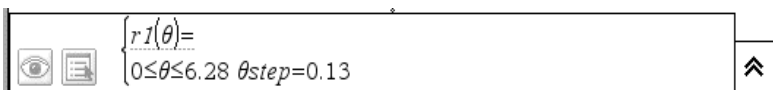
The image shows a software interface for entering parametric equations. On the left, there are two icons: an eye and a document. The main input area contains the following text: $\begin{cases} xI(t)= \\ yI(t)= \end{cases}$ and $0 < t < 6.28 \quad tstep=0.13$. On the right side, there is a small box with an upward-pointing arrow.

Parametric Mode entry line



The image shows a software interface for entering scatter plot data. On the left, there are two icons: an eye and a document. The main input area contains the text: $s1$, $x \leftarrow$ followed by a dropdown menu, $y \leftarrow$ followed by another dropdown menu. On the right side, there is a small box with an upward-pointing arrow.

Scatter Plot Mode entry line



The image shows a software interface for entering polar equations. On the left, there are two icons: an eye and a document. The main input area contains the following text: $\begin{cases} rI(\theta)= \\ \end{cases}$ and $0 \leq \theta \leq 6.28 \quad \thetastep=0.13$. On the right side, there is a small box with an upward-pointing arrow.

Polar Mode entry line

Additional Graphs & Geometry features

Keystroke shortcuts

There are keystroke shortcuts that can simplify your work with Graphs & Geometry. These are:

Keystrokes:

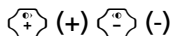


Task accomplished:

Removes a selected object from the work area.



When used with the Line or Circle tool, constrains Circle and some linear objects (Line and Ray) to discrete intervals (for example, Circle to integer radius values and linear objects to multiples of 15 degrees).




When a number is under the pointer, the + and - keys enable you to change the number of displayed digits.





When a number is under the pointer, the < and > keys decrease or increase a value.

Using the tab and arrow keys

While the pointer allows you to access the many features and tools contained in Graphs & Geometry, you can also use the  and arrow keys to access these features. Using these keys is easier or more convenient than using the pointer.

The  key:

- First tab stop: places the cursor to the right of the equal sign on the function entry line. This allows you to create a new expression.
- Second tab stop: highlights the Expand/Collapse entry line History button.
- Third tab stop: highlights the Hide/Show button on the entry line.
- Fourth tab stop: highlights the Attributes button on the entry line.
- Fifth tab stop: focuses on the Pause/Start button of the animation control bar, if present. If the Data Collection control bar is displayed, focuses on the Start/Stop button.
- Sixth tab stop: focuses on the graphing portion of the page and commits any editing changes. The pointer is active on the page.

Note: Press   to move through the steps in reverse order. If slider controls are included on the work area, the fifth tab stop

moves to the slider control. Press **Esc** to jump to a graph on the work area at any time.

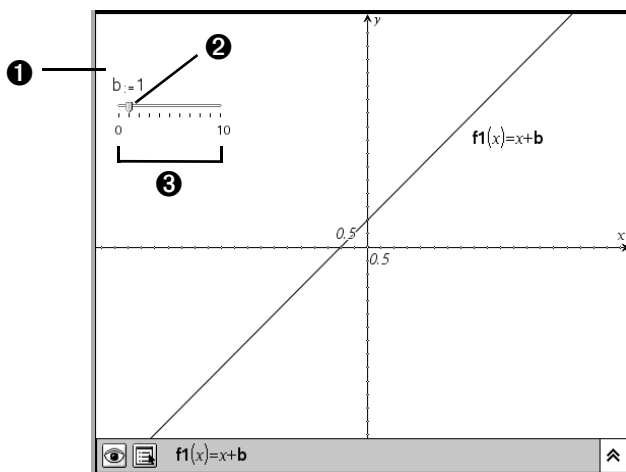
The arrow keys:

- Up and Down - moves up and down among functions in the function history list. Moves up and down any tool menu list as well as the attributes list. When using the Trace tool, enables you to move to and trace a different graph when more than one graph is on the page.
- Left and Right - moves along the entry line, one space or one button at a time. When using the Trace tool, moves the trace cursor along the graph, either left or right. When viewing an attribute list, steps through the options for one attribute.

Using Sliders

Sliders let you easily change the value of a numeric value in the Graphs & Geometry and Data & Statistics applications. Inserting a slider lets you represent multiple variable values in a continuous range. In the following example, the slider represents the numeric variable, **b** in the graphed function.

- ▶ To insert a slider, select **Insert Slider** on the **Actions** menu. The slider displays on the work area.



- 1 Variable statement that includes the name of a numeric variable in an entry field, the assignment operator ":=", and the value set for the numeric variable in a second entry field

- 2 Slider that you can move to values on the scale when the control is active
- 3 Track with labels for the minimum and maximum values on the scale and scale tic marks between the end values

Basic slider operation

To change the default variable name ($v1$), click the text box on the left, highlight the default name, and type the name of the variable that you want the slider to represent. You can move the slider to set the variable to a value, or type a number in the text box after the equal sign. Press **Esc** or click another part of the work area to unselect a slider.

You can use a slider in the following ways:

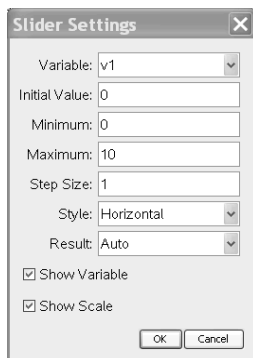
- Grab the slider and drag it to set the variable to any value within its range.
- Click a point near the slider track to grab the entire control for operations such as copying, moving, and deleting.
- Drag the track ends to change the length of the slider scale.
- Click the text box for the slider variable name and type the name of the numeric variable to use. You can use an existing numeric variable or use the slider to create a new one.

Context menu and slider settings

To change the settings for a slider, access the slider context menu:



Select **Settings** to display the **Slider Settings** dialog:



Specify the values to use for the slider:


Variable	Sets the name of the numeric variable used with the slider. Type the value in the field or click the drop-down arrow to select a value from the list.
Initial value	Sets the starting value of the variable.
Minimum	Sets the lowest value in the range of values used with the slider. This value displays at the left end of the scale.
Maximum	Sets the highest value in the range of values used with the slider. This value displays at the right end of the scale.
Step Size	Sets the size of the increment between values. When a slider is active, you can use the arrow keys to move the slider up or down the scale by this amount.
Style	Lets you choose how the slider is displayed in the work area. Choose horizontal for a left-to-right scale, or choose vertical for a top-to-bottom scale. To display a slider that includes the variable name, current value, and direction arrows only, choose minimized.
Result	Lets you choose the format for the displayed value of a slider. Choose Auto to let slider operate in the default format, or choose from eight floating point formats.
Show variable	Shows or hides the variable.
Show scale	Shows or hides the scale on the slider track.

Animating a slider

From the slider context menu, click **Animate** to step through the variable range automatically. To stop the animation, click **Stop Animate**.

Minimizing a slider

From the slider context menu, click **Minimize** to show a smaller display that includes the variable name, the current value of the variable, and up and down arrows.

Minimized $v1 := 5.38$ 

Opening and exporting files

You can open Cabri II Plus™ Figures (.fig) files in Graphs and Geometry and open TI-Nspire™ .tns files in Cabri II Plus™. Cabri II Plus™ files that you open in Graphs & Geometry convert to a Graphs & Geometry page with converted figures and a Notes page with conversion messages. Each Graphs & Geometry page converts to a separate Cabri II Plus™ file when you open a .tns document in Cabri II Plus™.

Note: On a Macintosh computer, you cannot open a Cabri II Plus™ .fig file or a Learning Check .edc file. You also cannot export a TI-Nspire .tns document as a .fig file.

Opening a Cabri II Plus™ file

To open a Cabri II Plus™ figures (.fig) file in Graphs & Geometry:

1. Select **Open Document** on the **File** menu.
2. On the **Open TI Nspire Document** dialog, click **Files of Type** and choose **Cabri Plus II Figures (*.fig)**.
3. Click the .fig file that you want to open in Graphs & Geometry and click **Open**.

Converted Cabri II Plus™ figures display on a Graphs and Geometry page and conversion messages display on a Notes page. The file is saved as a .tns document.


Exporting a Cabri II Plus™ file

To export Graphs & Geometry pages of a TI-Nspire™ .tns document to Cabri II Plus™:






1. Open the .tns file that contains the Graphs & Geometry pages to export.
2. Choose **Export** on the **File** menu.
3. On the **Export to Cabri** dialog, click **OK** to save the .fig files in the current folder.



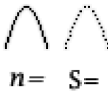
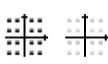
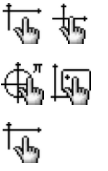
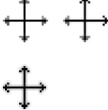
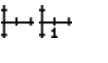
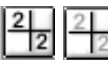
Each Graphs & Geometry application in the document will be converted to a separate Cabri II Plus™ file within that folder.

Attribute settings

The following table lists the attributes available when working with objects. The list of available attributes depends upon the object you select. To view attributes, select the Attributes tool .

When the tool is selected, move the cursor to the work area and select the object or function whose attributes you want to change. The column of attributes available displays on the work area near the object or function.

Name	Icon(s)	Options	Available for use on
Line Weight		Thin, Medium, Thick	Line, Tangent, Segment, Ray, Vector, Circle, Circle arc, Triangle, Polygon, Regular Polygon, Rectangle, Graphed Functions, Integrals, Polar Equations, Parametric plots
Line Style		Solid, Dashed, Dotted	Line, Tangent, Segment, Ray, Vector, Circle, Circle arc, Triangle, Polygon, Regular Polygon, Rectangle, Graphed Functions, Polar Equations, Integrals, Parametric Plots
Animation		Unidirectional Animation Speed, Alternating Animation Speed	Point, Point On
Fill		No fill, White, Light Grey, Med Grey, Grey, Dark Grey, Black	Circle, Triangle, Polygon, Regular Polygon, Rectangle, Integrals
Lock/Unlock			Point, Point On, Intersection Point, Length, Perimeter, Area, Angle

Name	Icon(s)	Options	Available for use on
Point Style		Small dot, Large dot, Hollow circle, Solid square, Hollow square, x, +	Point, Point On, Intersection Point
Activation		Point Activated, Point Deactivated	Points
Graph Appearance		Continuous, Discrete, Number of Points, Step Size	Graphed Functions, Polar Equations, Parametric Curves
Axes Style		Grid, No Grid	Axes
Axes Settings		Axes user settings, Axes Quadrant 1 settings, Axes Trig settings, Axes Stat settings, Axes standard settings	Axes
Axes End Style		No Arrow, Positive Arrows, All Arrows	Axes
Axes Tic Labels		Tic labels are shown, Tic labels are hidden	Axes
Axes End Values		End Values are shown, End Values are hidden	Axes
Line Equation Type	$y=...$ $...=0$	Cartesian ($y=_$), Canonical ($_ =0$)	Line, Tangent, Segment, Ray, Vector

Name	Icon(s)	Options	Available for use on
Equation Type		Canonical (...=0), Cartesian (...=r ²)	Circle
Plot Points		Discrete Points, Connected Points	Parametrics, Scatter Plots, Polar equations
Labels	f f() f()=.. y=f() y=...	y=, f(), f()=, y=f(), f,	Graphed Functions

Changing the thickness and style of a line/outline

You can control the thickness and appearance of the lines and outlines of shapes that you create on the screen. To adjust the thickness of the lines:

1. From the **Actions** menu, select the **Attributes**

Press .

2. Select the object whose line you want to change.

Use and to move through the list of attributes.

3. Highlight the thickness option, and use or to move through the thickness options.

As you move through the options, the thickness immediately changes on the screen.

4. When the desired thickness displays on the screen, press or click to confirm the change.

The Attributes bar disappears.


Use the same method to change the style of the line, selecting the style attribute, instead of the thickness attribute.

Locking measured values and points

Graphs & Geometry allows you to lock one or many values or points. To do this:

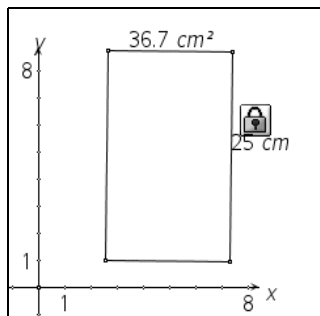
1. From the **Actions** menu, select **Attributes** .

Press .

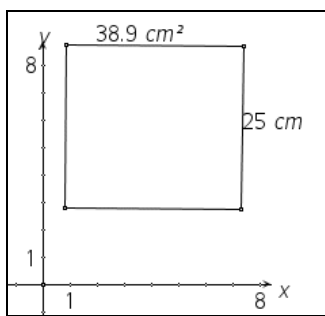
2. Select the value or point that you want to lock.
3. Use ▲ and ▼ to locate the Lock attribute.
4. Use ◀ or ▶ to select **Lock**.
5. Click or press  to lock the value or point.

A lock icon appears near the locked value or point.

An example of when locking measured values is useful is the problem of maximizing an area contained within a fixed perimeter. In this case, a rectangle is created with the correct perimeter, and both the perimeter and area values are displayed. The perimeter value is locked. As you alter the sides of the rectangle, the perimeter remains unchanged but the area changes. When the optimum area displays, you can measure the sides to obtain the necessary dimensions.



Initial rectangle with locked perimeter



Optimized area with same initial perimeter

Working with functions




The entry line under the work area lets you specify functions in the format supported for each graph type in Graphs & Geometry.

Using the entry line




The entry line displays at the bottom of the page. The entry line displays the form to use to type the function that corresponds to the selected graph type. To type details for a function on the entry line:

1. Select the graph type to set the graphing mode. You can specify multiple functions for each graph type. The default graph type is Function, so the form $f1(x)=$ displays.
2. Type the data for the type of function you want to graph using the function formatting that displays on the entry line:




- To graph a function, select **Function** on the **Graph Type** menu. The work area and entry line change to function mode. Enter an expression for the function after the equal sign.

Press   .




- To graph a parametric equation, select **Parametric**. The work area and entry line change to parametric mode. Type expressions for $xn(t)$ and $yn(t)$. Specifying alternate values for the default t-min, t-max, and t-step displayed is optional.

Press   .

- To graph a polar equation, select **Polar**. The work area and entry line change to polar mode. Type an expression for $rn(\theta)$. Specifying alternate values for the default θ -minimum and θ -maximum, and θ -step displayed is optional.

Press   .




- To graph a scatter plot, select **Scatter Plot**. The work area and entry line change to scatter plot mode. Click the arrows that display to choose x and y for sn .

Press   .



3. Press  or .

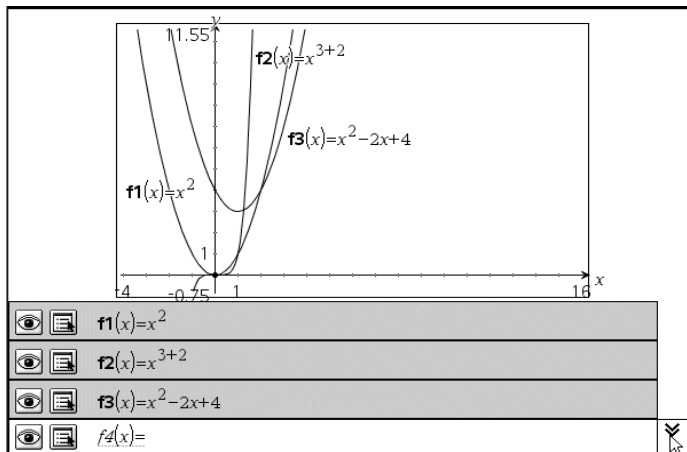
After your selection is graphed, the entry line changes to enable you to specify another graph of the same type. For example, after you graph $f1(x)$, the entry line changes to $f2(x)=$ to enable you to enter another function. If you select or trace a function, that function displays on the entry line.

As you graph multiple functions on one set of axes, Graphs & Geometry labels each with its function. You can define and graph a maximum of 99 functions of each type. For example, you use function mode to specify functions ($f1(x) - f99(x)$). You can also rename multiple functions that use custom names, for example, $g1(x)$.

Note: If you draw a geometric figure, the entry line may disappear from the page. Press   to select the Show Entry Line tool .

Using the entry line expand button

Click the entry line to display a line-by-line history list of the functions entered on the screen. The list displays functions in the order of entry (top to bottom), with the most recent entry closest to the entry line. Use  and  to move up and down the list.

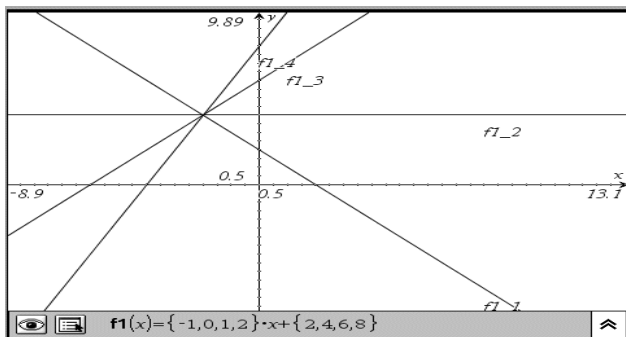


Use the function history to edit, change the attributes of, delete, or hide (or redisplay) a specific function or graph.


Graphing a family of functions

A family of functions differ by one or more parameters and can be specified with a single expression. To graph a family of functions:

1. Type an expression for a family of functions on the entry line. To specify a family of functions:
 - Specify the parameters as one expression for multiple functions using the format $f1(x) = \{-1, 0, 1, 2\} * x + \{2, 4, 6, 8\}$ or $f1(x) = m * x | m = \{1, 2, 3\}$.
 - Enclose the lists of numbers or lists of variables in curly brackets.



For example, four functions are denoted with the expression: $f1(x) = \{-1, 0, 1, 2\} * x + \{2, 4, 6, 8\}$. The first function to be evaluated is $y = -1 * x + 2$ and the second is $0 * x + 4$.


2. Press  to graph the family of functions specified.




Graphs & Geometry creates and displays a separate graph object for each member of the family of functions. Each function is labeled (f1_1, f1_2) to indicate its sequence in the expression. You can select, move, or trace the graphs to explore them.

Note: Editing a single function graph to change it to a family of functions is not supported.

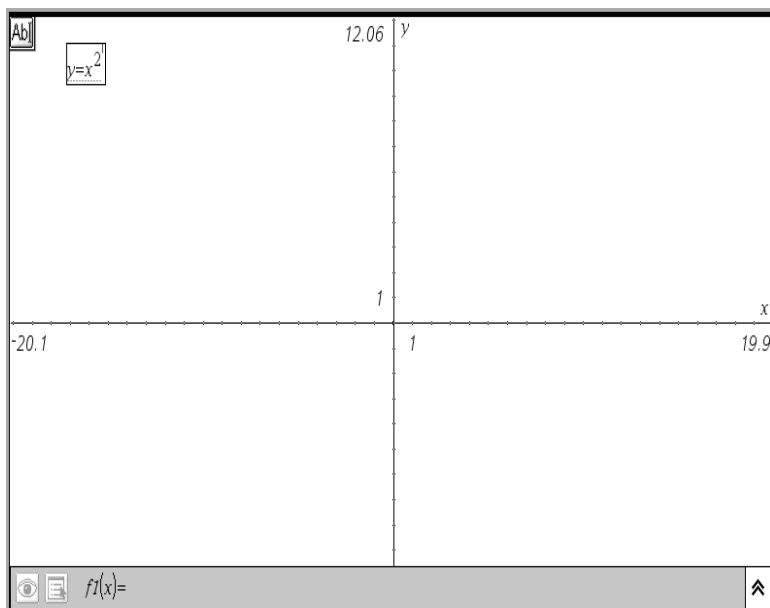
Using the Text tool to enter functions

You can graph functions, including functions of the form "y=", by typing them into a text box. To graph a function this way:

1. From the **Actions** menu, select the Text tool .

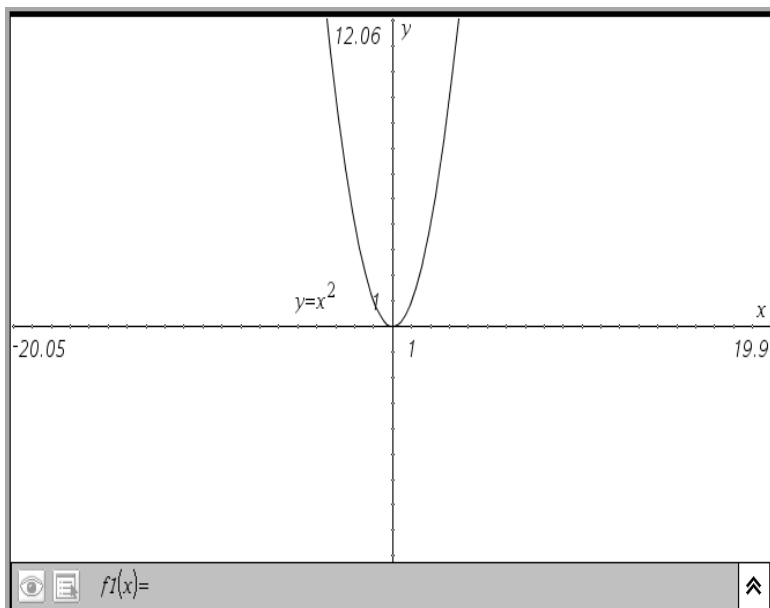
Press   .

2. Click the work area to place the text box. Type the function you want to graph.



3. Drag the text box to the x-axis, and drop it on the axis.


Graphs & Geometry graphs the function on the axes.

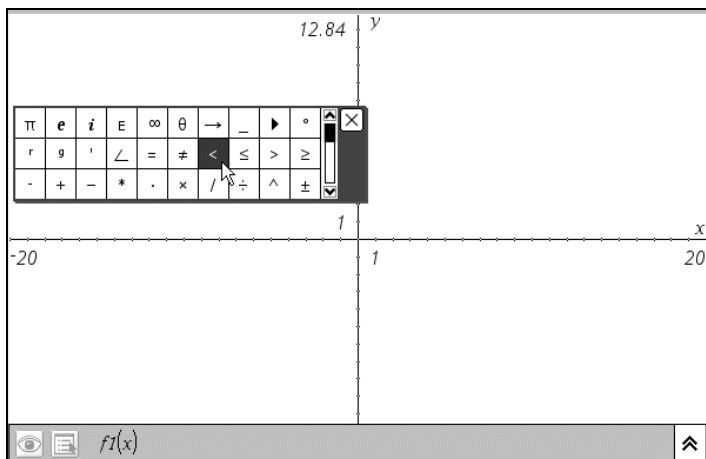


Regardless of how you enter functions, each function is labeled on the graph for identification.


Graphing inequalities

Function mode enables you to define a function that uses a symbol other than the equal sign. To change = to a different sign and graph the inequality:

1. Position the cursor to the right of the equal sign.
2. Delete the equal sign:
 - Press .
3. Type the desired sign or use the Symbol Palette to enter the appropriate inequality. The possible inequalities are: $>$, $<$, \leq , and \geq .



4. Type the rest of the inequality expression.


Press  to graph it.

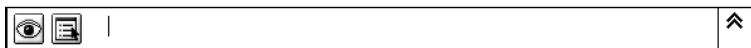
The expression, as typed, displays next to the graph. Shading is always present on the graphs of inequalities to show the values that satisfy the inequality. If you graph two inequalities that overlap, the area of overlap is shaded darker than either of the individual inequality graphs.

Renaming $f(x)$

$fn(x)$ is the default naming convention for functions and inequalities entered into Graphs & Geometry. The number, represented by n , increases as you enter more functions.


To change $fn(x)$ on the entry line:

1. Place your cursor to the right of the = sign in the entry line.
2. Clear the line:
 - Press  until the line is blank.

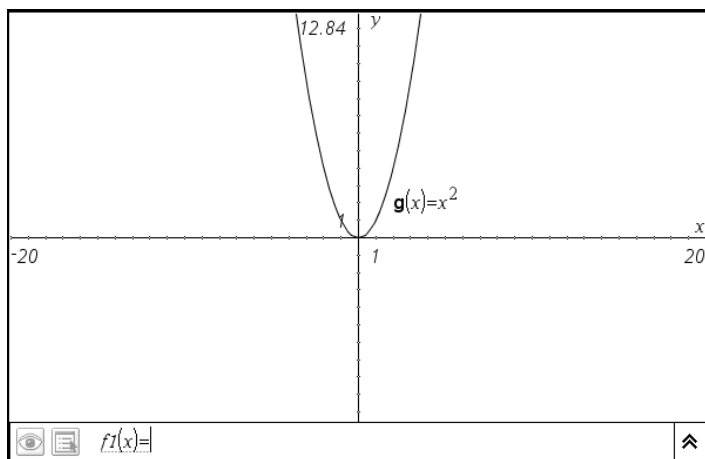


3. Type the letters/numbers for the system you want to use, and then type the function or inequality you want to graph.



4. Press  to graph the function.

Notice that the label shown next to the graph is identical to what you entered.



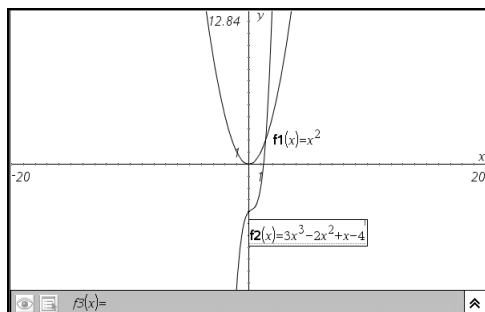
Note: When you use a customized naming convention, you must manually rename each function or inequality entered to continue the custom naming convention.

Editing functions

You can edit graphed functions, one function at a time. To edit a function:

1. Use one of the following methods to access the function:
 - Press **(esc)** and double click the function label on the graph.
 - Use the entry line Expand button or the up arrow to move to the function.

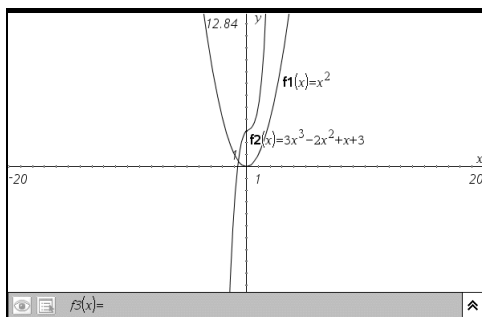
The expression displays in a text box, ready to edit.



2. Move the cursor to the portion of the function you want to change.
3. If you are adding to the expression, type the new characters into the function.

If you need to delete a portion of the function, remove the unneeded characters and type any new characters.

4. Press $\left[\frac{\square}{\text{enter}} \right]$ to graph the revised function.

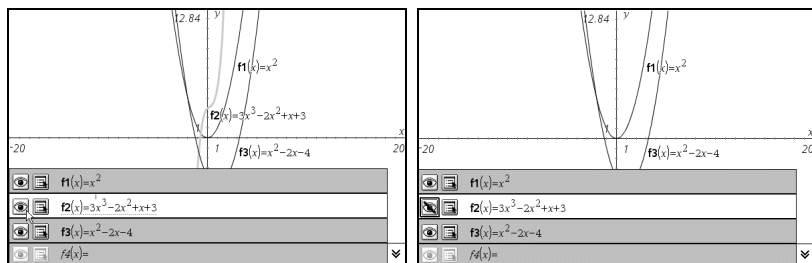


Hiding a function on the work area

1. Click the **Expand** button or press $\left[\text{tab} \right]$ until the **Expand** button has focus, and then press $\left[\frac{\square}{\text{enter}} \right]$ to display the function history list.
2. Use the function history list to locate the function you want to hide on the work area.
3. Click the Hide/Show button $\left[\text{eye} \right]$ to the left of the function.

The graph of the function as well as its label are hidden on the screen. The Hide/Show button appearance changes in the list to indicate that the function is hidden. To redisplay the function, repeat the steps above.

Note: You can also hide a function by first selecting **Hide/Show** on the **Actions** menu, clicking the function on the work area, and pressing **Esc** to exit Hide/Show.



Deleting a function

To remove a function from your graph:

1. Select the function by clicking on its graph.




You can also select a function by using the **Expand** button to list all functions on the work area, then selecting the function in the list.

2. Press .

The function is removed from the page and from the list of graphed functions.

Clearing the work area

1. To remove all functions and objects from the work area at one time, select **Actions > Delete All**

Press   .

The system displays a delete confirmation box.

2. Select **Yes**, and all objects and functions are deleted.

The axes remain displayed.

The Trace tools

Graphs & Geometry provides two trace tools:




- Graph Trace - point-by-point trace of the graph for a function, parametric or polar equation, or scatter plot.
- Geometry Trace - trail of functions or objects.

There is also an Erase Geometry Trace tool. This removes all geometry trace echos from the work area.






Using Graph Trace

Graph Trace moves through the points of a graphed function, parametric, polar, or scatter plot. To enable the trace tool:



1. Select the Graph Trace tool .

Press   .

The trace point displays on the graph.

2. Graph trace enables the following operation:
 - Press   to move along the function's graph. The coordinates of each point display during the trace.
 - Press   to move from one function graph to another or to a scatter plot. The point's coordinates update to reflect the new location of the trace. The trace cursor is positioned on the point of the new graph or plot with the closest x value to the last point identified on the previously traced function or graph.
 - View the points of interest ("Z" for zero, "M" for local maximum, and "m" for local minimum) that display as you trace a function's graph.
 - Type a number and press  to move the trace cursor to that x value on the function's graph.

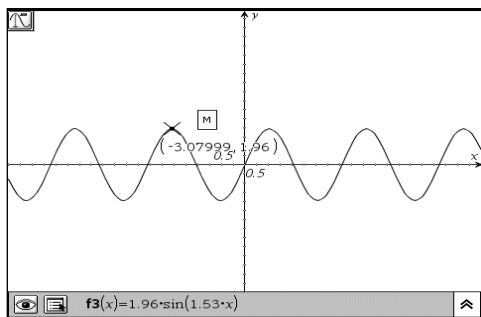
Notes:

- When you trace beyond the initially visible graph, the screen pans to show the area being traced.
- To set the Trace Step increment to use between consecutive jumps during the trace, select the Trace Settings tool . Click **Enter Value** and type the increment. Otherwise, the increment between the "steps" of the trace is set automatically to the increment specified when you defined the function.
- To create a persistent point while in Graph-Trace mode, press .
- To trace several functions simultaneously, press the up or down arrow key until the cursor becomes a vertical dashed line. The coordinates of the intersection with the dashed line display for each function graph. Use the left/right arrow

keys to move the cursor. Vertical movement is not supported. You cannot trace multiple polar and parametric equations simultaneously.


- When you select or trace a function on the work area, that function displays on the Edit Line.
- If you select another tool, Graph-Trace becomes inactive.

To exit Graph-Trace mode, press esc .




Trace point on a sine graph

Using Geometry Trace

The Geometry Trace tool  enables you to leave a visible trail of an object when it is moved on the work area. The movement can be done manually or by using the Animation tool.

Note: The trace trail cannot be selected or manipulated.

To use Geometry Trace:

1. Create an object or function.
2. From the **Trace** menu, select the **Geometry Trace** tool .

Press menu $\langle 5 \rangle$ $\langle 3 \rangle$.

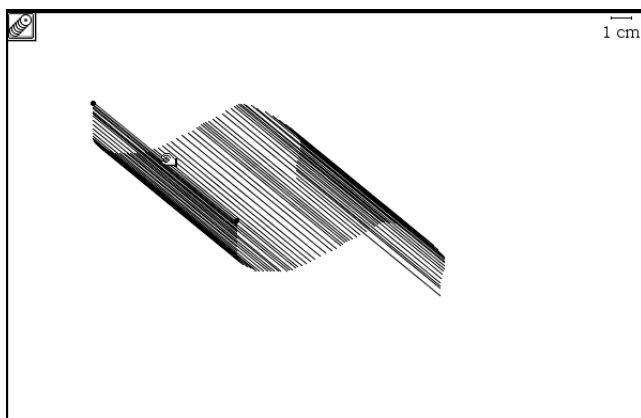
3. Click the object or function. Either:
 - manually grab and move the object, or
 - select a point and animate it.

If you use animation, the point must be selected for geometry trace as well as animation.


The amount of trace track displayed on the work area depends upon the amount of movement.




- If the object moves very little, then the entire track remains displayed until you erase it.
- If the object moves a lot, the track can obscure a significant portion of the work area. In this case, the older portions of the track fade out to prevent the work area from becoming obscured by the track.

In the following example, a line segment was drawn and selected for geometry trace. Movement of the segment was done manually.

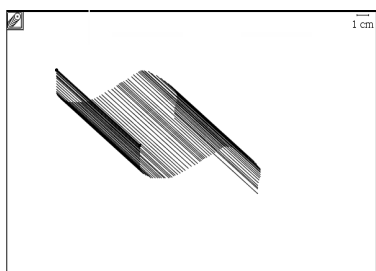


Using Erase Geometry Trace

The easiest way to remove the trace tracks from the work area without deleting any objects or functions is to select the Erase Geometry Trace tool .

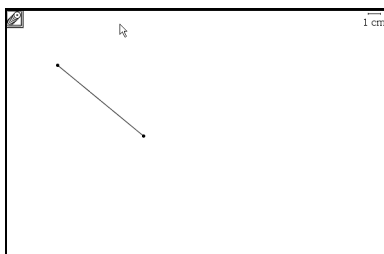
Press   .

When selected, this tool removes immediately all trace tracks from the work area.







Erase Geometry Trace tool being selected.

Work area after trace track erased.



Manually manipulating functions

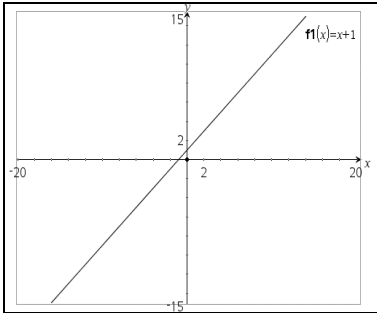
When you have graphed a function, you can use the Pointer tool  to translate, stretch and/or rotate it by grabbing its graph. As you maneuver the graph, its symbolic representation also changes.

Press   .

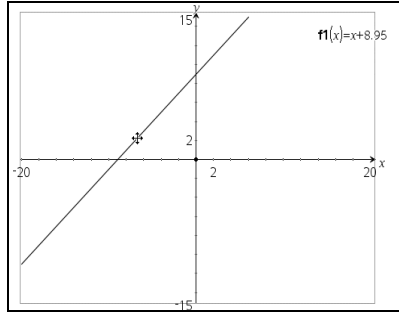
You can manipulate the following types of functions:

- Linear function; $y=b$
- Linear function; $y=ax+b$
- Quadratic function; $y=a(x-b)^2+c$
- Exponential function; $y=\exp(ax+b)+c$
- Exponential function; $y=b*\exp(ax)+c$
- Exponential function; $y=d*\exp(ax+b)+c$
- Logarithmic function; $y=a*\ln(cx+b)+d$
- Sinusoidal function; $y=a*\sin(cx+b)+d$
- Cosinusoidal function; $y=a*\cos(cx+b)+d$

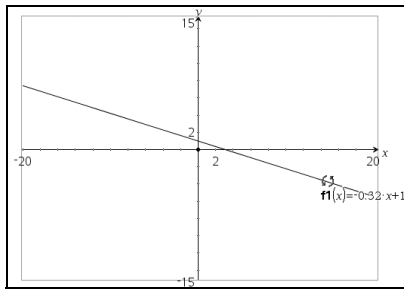
Manipulating a linear function



Initial function graph

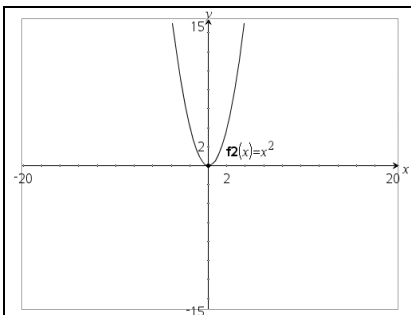


Function translated along the x-axis. (Notice the revised function label) To translate, "grab" near the middle of the graph then drag.

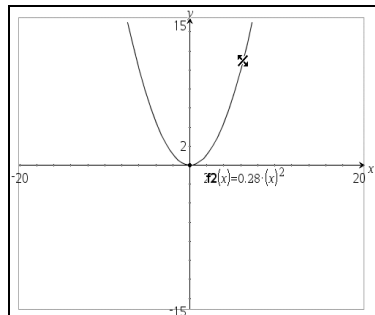


Manually rotated function. To rotate, "grab" near the ends of the graph then drag.

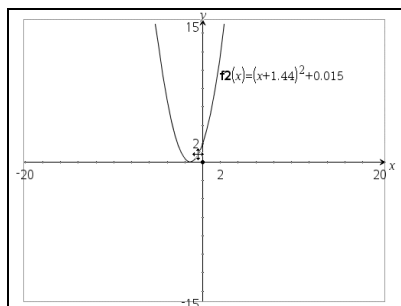
Manipulating a quadratic function



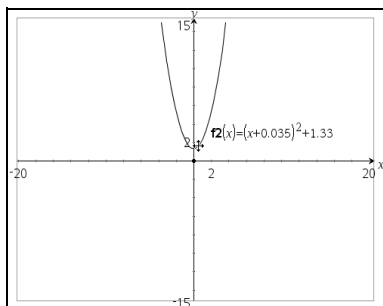
Original quadratic function



Manually rotated function. To stretch, "grab" away from the vertex of the graph then drag.



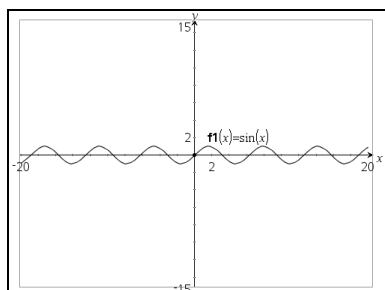
Function translated on the x -axis



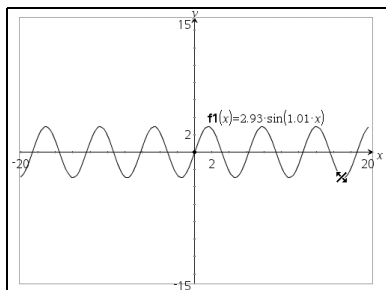
Function translated on the y -axis

To translate, "grab" near the vertex of the graph then drag.

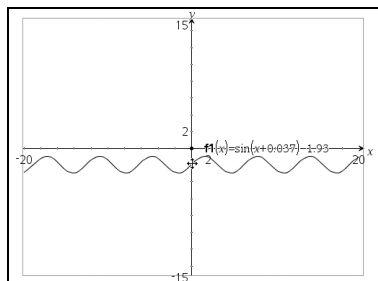
Manipulating a sine or cosine function



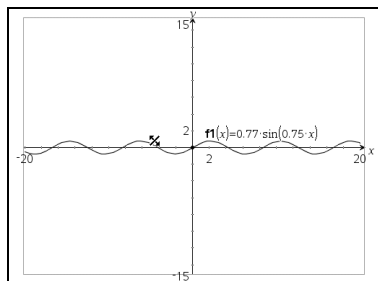
Original sine function



Rotation manipulation of the sine function. To stretch, "grab" away from the axis of vertical symmetry of the graph then drag.



Translation manipulation along the y -axis.



Translation manipulation along the x -axis.

To translate, "grab" near the axis of vertical symmetry of the graph then drag.

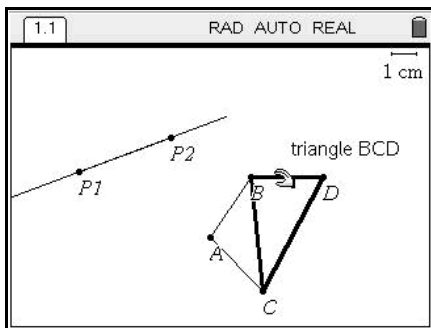
Working with multiple objects at one time

You can select multiple objects and perform the same actions on them.

Selecting multiple objects

There are two ways to select multiple objects. To select using the pointer:


1. Click the first object you want to select. A label indicates the type or name of the object selected and the outline of the shape blinks to indicate selection.



2. Move to the second object and click it.
3. Continue selecting objects in this way until you have clicked each item you want to select.

As each object is selected, its shape outline blinks.

To select using a selection box:

1. Click the Select tool  and click one corner of the region you want to select.




As you move the cursor, a box outline appears on the screen.

2. Move the cursor around the screen until all or a part of all the objects you want to select are contained in the box.
3. Click a second time to complete the selection box. The selected objects and the axes flash to indicate that multiple items have been selected.




To cancel selection of objects:

1. To cancel selection for one object, click the object a second time.


2. To cancel selection all selected objects, click on a space without any objects.

Note: If you need to cancel selection for an individual object in a group of objects, use a selection box to activate the group. After the objects begin to blink, either position the cursor on the object and press  or press  to reach the object and press .

To cancel the selection box selections:

1. To cancel the selection box before it is completed, press  or .
2. To cancel the selection box after it is completed, click on a clear space in the work area without any objects or press .

Deleting multiple selections

- ▶ To delete multiple selected objects, press .

Note: The origin and the axes cannot be deleted even if they are selected for deletion.

Moving multiple selections

1. To move all selected objects, move the cursor to one of the objects. The cursor changes to indicate that the object can be grabbed.
2. "Grab" the object and move it to the new location. All other selected objects will move along with the object moved by the cursor.

Note: If any non-moveable object is selected with moveable objects, then all objects must be moved individually. Examples of objects that cannot be moved in a multiple selection are objects attached to an axis, locked objects, and objects defined by one or more objects with a locked point or value.

Drawing and working with points and lines

In addition to graphing functions, you can also use the axes to draw points and lines. The types of points and lines you can create are:

- Points: Point, Point on, Intersection point(s)
- Labeling and naming a point
- Redefining a point
- Lines
- Rays

- Segments
- Segment with defined midpoint
- Parallel line
- Perpendicular line
- Vectors
- Tangent


Points




There are three tools for creating points:

- Point
- Point On
- Intersection Point


Creating a point




You can create an independent, moveable point using the Point tool.

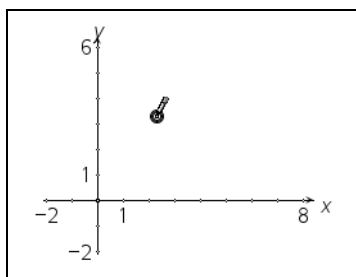
1. From the **Points & Lines** menu, select the Point tool .

Press   .

2. Move to the work area, and click to create a point.

You can move the point about the graph using the Pointer .

Press   .



Note: Although two points define a line, you do not create lines with the Point tool.

Creating a point on a specific object

1. From the **Points & Lines** menu, select the Point On tool .

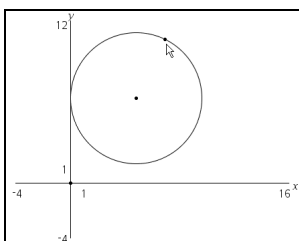
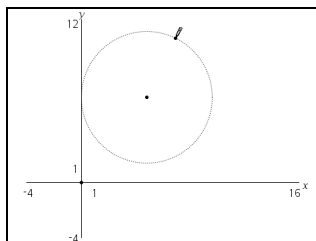
Press .

- Click on an object to create a specific point on the object.

You can move the point about or along the object using the Pointer



Press .



Defining an intersection point(s)

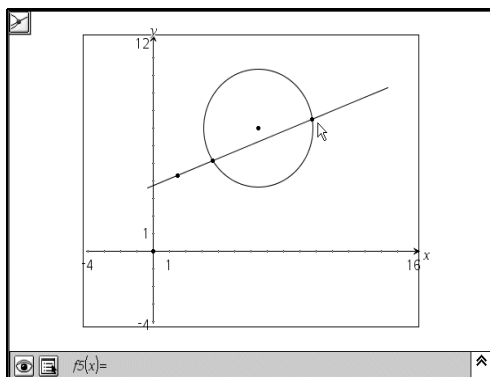
Note: To use this tool, two drawn objects must have one or more intersection points.

- From the **Points & Lines** menu, select the Intersection Point tool .


Press .

- Click on one object near its intersection with a second object.


The exact intersection point between the two objects is drawn. If the two objects intersect in more than one place, all intersection points are drawn.







Labeling (identifying) a point

You can identify the coordinates of any Analytic point (which you construct in the Graphing view, or within the Analytic Window of the Plane Geometry view) using the Coordinates and Equations tool . To label a point:


1. In the Graphing view, create a point if it does not exist.

You can also select a point on an object using the Point On tool .

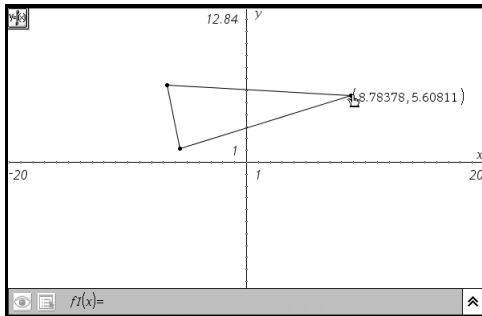
2. From the **Actions** menu, select the Coordinates and Equations tool .

Press   .

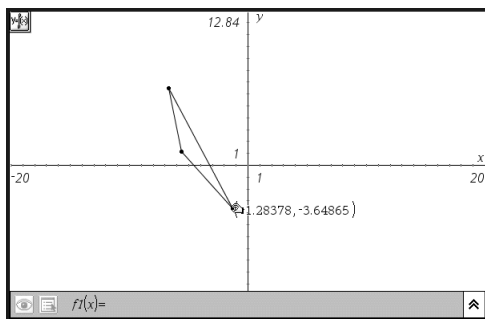
Move the cursor toward the point's location, and the coordinates blink.

3. To add the coordinates to the work area, click to select the point and then press , or click the point to anchor the coordinates on the work area.

The coordinates stop blinking and are displayed in parentheses. The format used is based upon the Locale you selected.







If you move the point to a different location, the new coordinates are updated to the new position.



Naming a point

You might not need to label a point but instead, you want to name it for easy reference. You can name points and vertices, regardless of the Graphs & Geometry work area view. Since they are not tied to a specific coordinate, names remain unchanged if you alter the location of any portion of an object. There are two methods for creating names.

1. One method is to use the Text tool  after you create an object.

Press   .

2. A second method is to name them as you create them. To add a name as you create an point, type a letter or name immediately after you define the point.

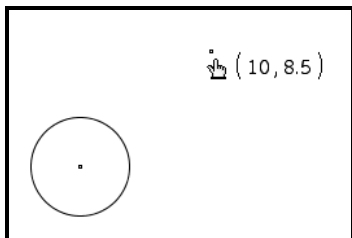
For example, when creating a triangle, typing the letter “x” after creating the first vertex names that vertex “x”. The two remaining vertices can be named “y” and “z” in the same way when they are created.


Redefining a point




You can redefine a point from an open area to an object, from one object to another, or from the analytic to the geometric zone (or vice versa.) To redefine a point:

1. Create a point.

(Note that in the examples, the point coordinates are labeled.)

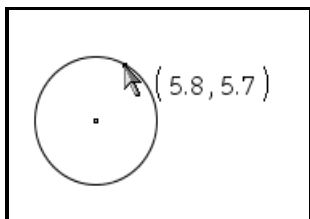


2. From the **Actions** menu, select the Redefine tool .

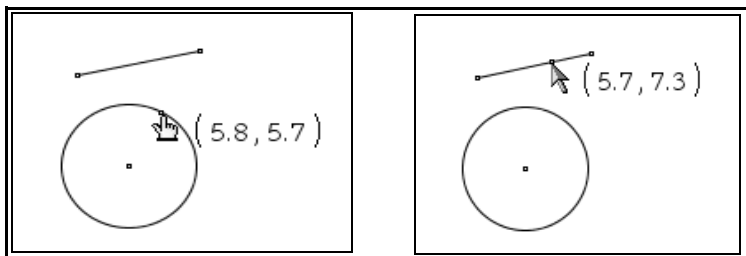
Press   .

3. Select the point to be redefined, then select the object.

The point moves to the object.



Note: A point can be redefined from one object to another. The procedure is the same as described above.







In these examples, the point is redefined from the circle to the segment.

Linear objects

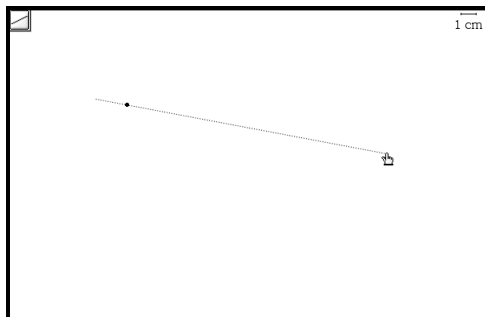
The linear objects you can create and explore are located on the **Points & Lines** menu. Graphs & Geometry creates “smart” lines and rays. This means that the meaningful portion of the line or ray is displayed rather than having the object project to infinity. This feature reduces clutter on the work area.


Creating a line

1. From the **Points & Lines** menu, select the Line tool .


Press   .




2. Click a location to start your line.
This click defines one point on the line.
3. Move and click again to define the direction of the line.
Graphs & Geometry draws the line.



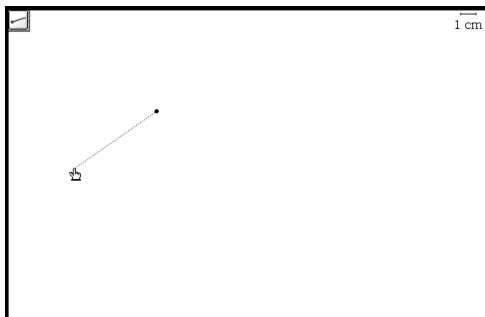
Note: If you press and hold  while creating the line, you limit its orientation (relative to the x-axis or the horizontal aspect of the screen), by 15° increments.

Creating a ray


1. From the **Points & Lines** menu, select the Ray tool .

Press   .

2. Click to define the endpoint of the ray.
3. Move the cursor and click again to define the direction of the ray.
Graphs & Geometry draws the ray.






You can create a ray anywhere in the work area, regardless of the axes' location.

Note: If you hold down the  key while creating the ray, you limit its orientation, relative to the x-axis or the horizontal aspect of the screen, by 15° increments.

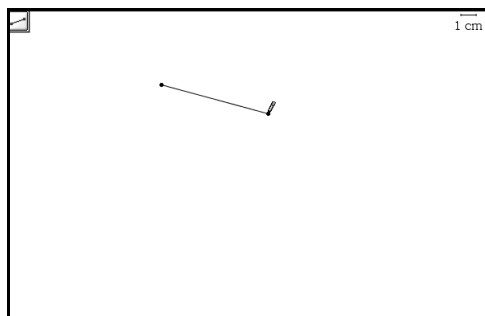
Creating a line segment

1. From the **Points & Lines** menu, select the Segment tool .

Press   .

2. Click to define the first endpoint of the segment.
3. Move the cursor and click again to define the second endpoint of the segment.

Graphs & Geometry draws the segment on the page.






Creating a line segment with defined midpoint

With the Midpoint tool , you can define a midpoint:

- on an existing line segment,

- between two specified points on a line,
- between two points on a page as you create the points. The midpoint is located and identified between the points. When the second point is selected, the midpoint is also created on the page.

1. From the **Construction** menu, select the Midpoint tool .

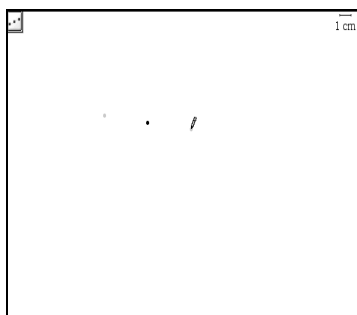
Press   .

2. Click at the location to start the segment.

As you move the cursor on the work area, a second end point appears. In between the starting point and this end point, you will see the midpoint.

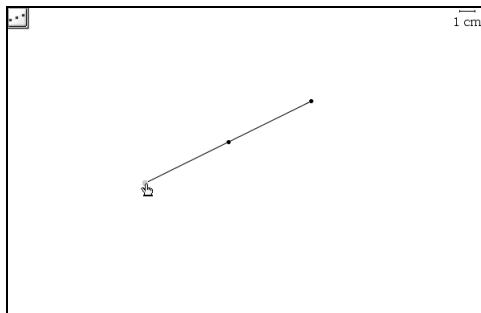
3. You can move the segment in any direction until you click on the work area a second time.

With the second click, the segment is anchored and the midpoint remains identified.




Midpoint defined
between two points.

4. If you are defining the midpoint of a segment or a segment on a line, click at the first endpoint of the segment.
5. As you move the cursor along the segment or line, a second endpoint and the midpoint appears.
6. Click at the second endpoint to define the segment and anchor the midpoint.



Midpoint defined for an existing segment.

Repositioning segments with midpoints

1. To reposition the segment after placing it on the work area, click the Pointer tool .

Press **(menu)** **1** **1**.

2. Select the segment and drag it to a new location without changing its orientation or length, or select one endpoint and drag it to a new location.

If just an endpoint is moved and if the length of the segment changes, then the midpoint is repositioned to remain at the middle of the segment.

Creating a parallel line

You can create a parallel line with respect to any existing line on the work area including the axes, and the side of any triangle, square, rectangle and polygon.

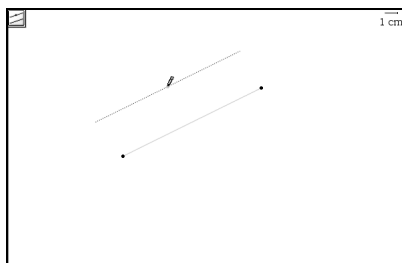
1. From the **Construction** menu, select the Parallel tool .

Press **(menu)** **9** **2**.

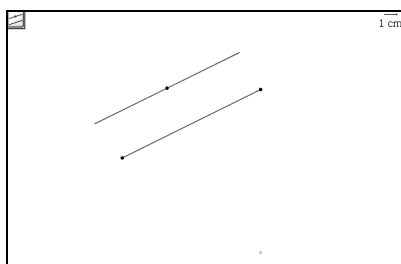
2. On the work area, click once on an existing line, segment, or axis.
This click identifies the reference line for the new parallel line you are creating.

3. Move the cursor away from the reference line, axis, or segment.
Notice that a dotted line displays, representing the parallel line.

4. When the dotted line is in the desired position, click again to anchor it on the work area.



Parallel line following cursor







Anchored parallel line

Note: You can also click first on the work area and then select the reference line to create the parallel line.

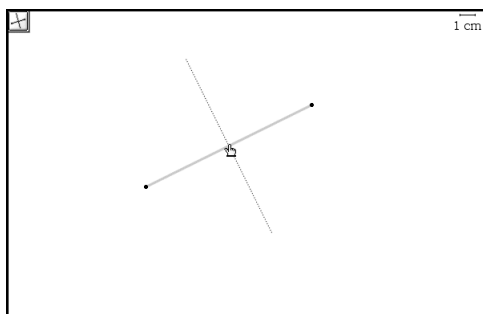
Creating a perpendicular line

You can create a perpendicular line with respect to any existing line or segment in the work area including the axes, and the side of any triangle, square, rectangle or polygon.

1. From the **Construction** menu, select the Perpendicular tool .

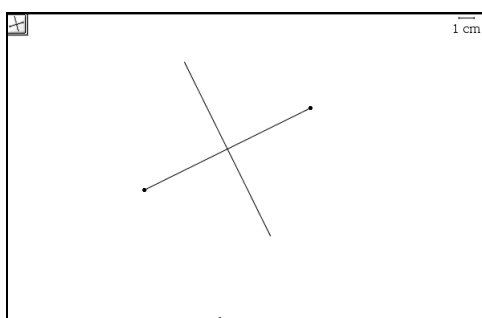
Press   .

2. Move the cursor onto the work area and click a point through which the perpendicular line should run. A dotted line shows the position for the perpendicular line.




Perpendicular line before anchoring to page




- Click again to anchor the perpendicular line. The dotted line changes to a solid line.



Anchored perpendicular line


Note: Alternatively, you can double-click the line or segment to create at the point where you want the perpendicular line to intersect.




- To move the perpendicular line to a different location on the reference line, select the Pointer tool .

Press   .

- Click the intersection point and drag the point and perpendicular line to the new location.

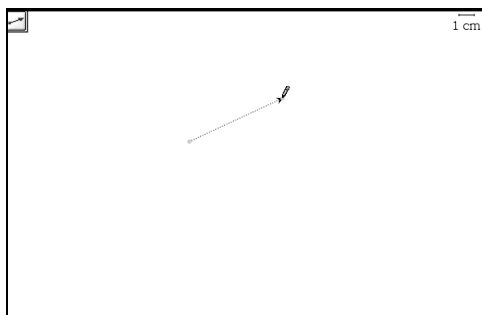
Creating a vector

- From the **Points & Lines** menu, select the Vector tool .

Press   .

- On the work area, click the spot from which the vector originates.
- Move the cursor in the direction of the vector.

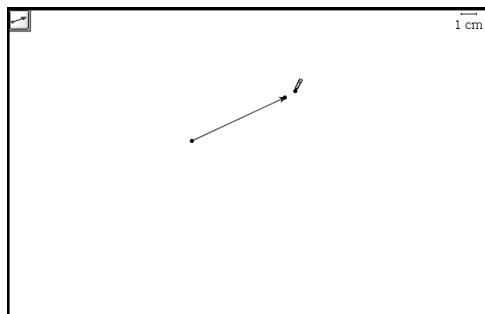
A dotted line follows the cursor as you move about the area.



Vector following cursor after identification of endpoint





- When the vector is in the correct position, click to anchor the vector on the work area.

The dotted line changes to a solid line.



Vector anchored to page

Moving a vector

- Select the Pointer tool .
Press   .
- Click on any point other than the endpoint and drag the vector to the desired location.






Resizing a vector

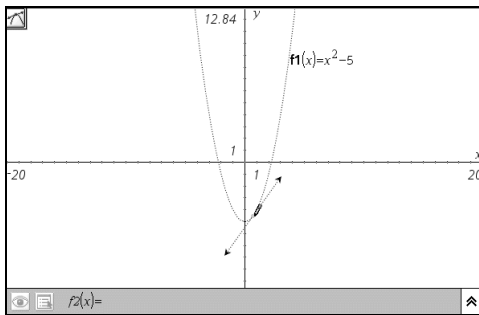
- Select the end point and drag it to the new location.

Note: If the endpoint is located on an axis, you can only move the endpoint of the vector along the axis.

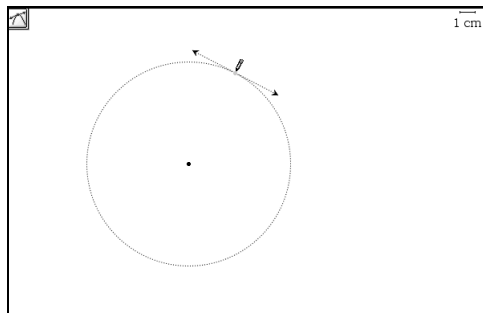
Creating a tangent

You can create a tangent by identifying a specific point on an existing object or function. To create a tangent line:

- From the **Points & Lines** menu, select the Tangent tool .
Press   .
- On the work area, select the point at which you want the tangent drawn.
A dotted tangent line blinks on the work area.
A dotted tangent line blinks on the work area.
- Click or press  to anchor the tangent on the work area.



Tangent of a graph




Tangent of an object




Creating and working with objects (shapes)

With Graphs & Geometry, you can draw:

- Circles
- Triangles
- Rectangles
- Polygons
- Regular Polygons

Creating a circle

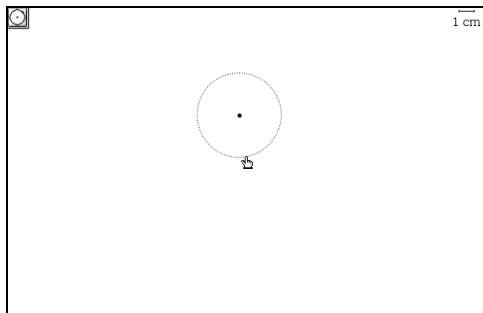
1. From the **Shapes** menu, select the Circle tool .

Press   .

2. On the work area, click once to establish the center of the circle.

Move the cursor away from this point.

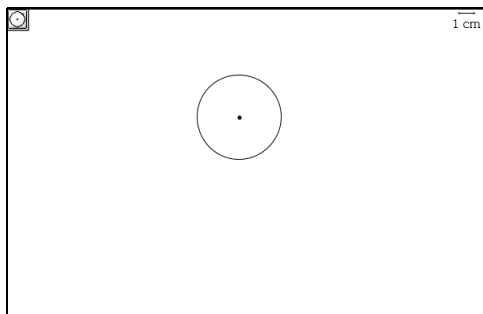
You will see a circle with a dotted circumference line emerge as you move the cursor.




- When the circle has the radius you desire, click again.

The dotted circumference changes to a solid circumference in the work area.





This second click does not define a point on the circumference; instead, it completes the circle construction.



Note: If you hold down the  key when creating the circle, the radius is limited in length to integers.

Moving a circle

You can move the circle to a different location without resizing it,

- Select the Pointer tool .
- Press   .
- Select the circle's center point.
- Drag the circle to the new location.

Resizing a circle

- Select a point on the circumference.




The circle blinks.

2. Drag the circle inward or outward to increase or decrease the circumference.
3. Release the mouse button to anchor the circle in the work area.

Creating a circle with the Compass tool

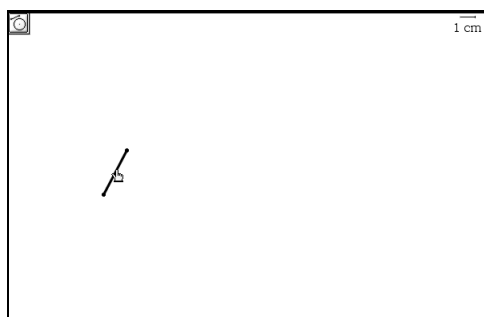
You can also create a circle with the Compass tool.

1. From the **Construction** menu, select the Compass tool .

Press   .

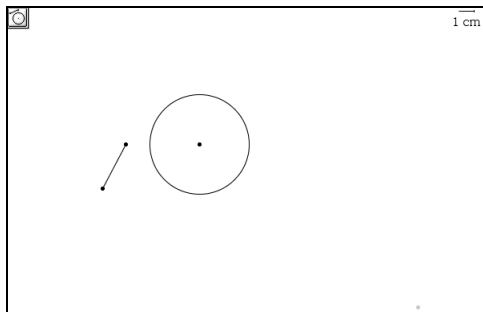
2. Move the cursor to the page and
 - select the segment to use as the circle's radius or
 - define two points.

The distance between these points will become the radius length for the circle.



Segment selected for circle's radius.

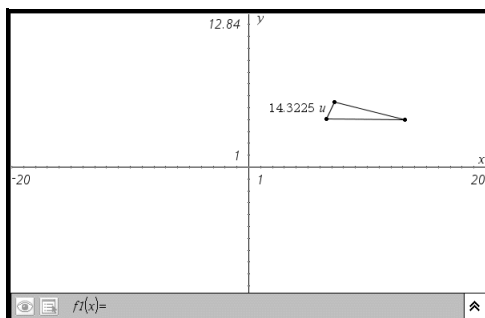
3. When you select the segment, a circle displays with the center point positioned under the cursor.
4. Move the circle to the desired location.
5. Click to change the circumference from a dotted line to a solid line and anchor the circle on the page.






Circle created with Compass tool and anchored on page.

You can use a measured length for the radius of a circle.

1. Select a segment or the side of a triangle or rectangle.
2. Measure the length, and display the length value on the page.

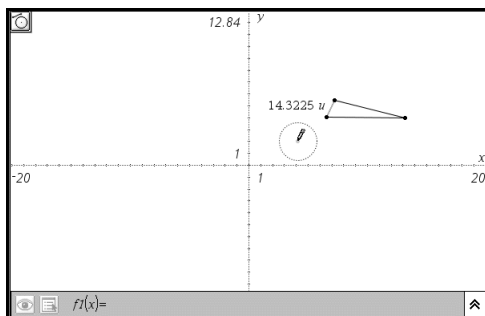


3. Select the Compass tool .

Press   .

4. Click the length value.

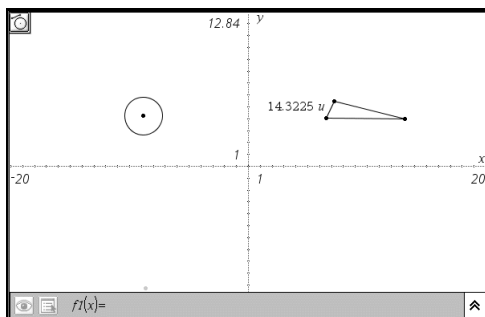
A circle with the radius of the selected length automatically appears.



Note: To use an expression or stored variable as the radius of a circle, use the Text tool on the **Actions** menu. For example, create a text box, type $2+3$, press $\left[\frac{\square}{\text{enter}} \right]$. Select the Compass tool, click on the text box. A circle with radius 5 is displayed.

5. Move to the desired location for the circle (it will follow as you move), and click to anchor it on the page.

The circumference line changes from dotted to solid.



Creating a triangle

1. From the **Shapes** menu, select the Triangle tool $\left[\triangle \right]$.

Press $\left[\text{menu} \right] \left[8 \right] \left[2 \right]$.

2. On the work area, click once to establish the first vertex of the triangle.
3. Move the cursor to the location for the second vertex and click again.

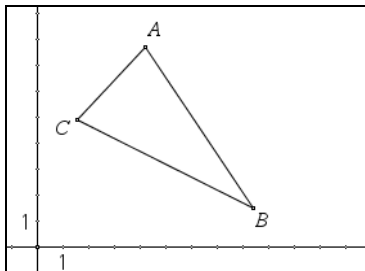
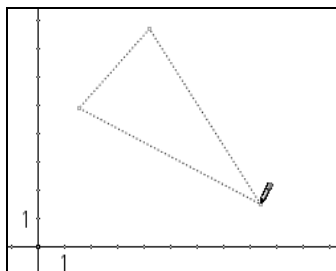
Notice that the side of the triangle is shown as a dotted line.

4. Move the cursor to the location of the last vertex.

As you move the cursor, all sides of the triangle are shown as dotted lines.





5. Click again to create the final vertex and anchor the triangle on the work area.

The sides are defined by solid lines.



Moving a triangle





You can move the triangle to a different location without resizing it.

1. Select the Pointer tool .
- Press   .
2. Select one side of the triangle.
3. Drag it to the new location.

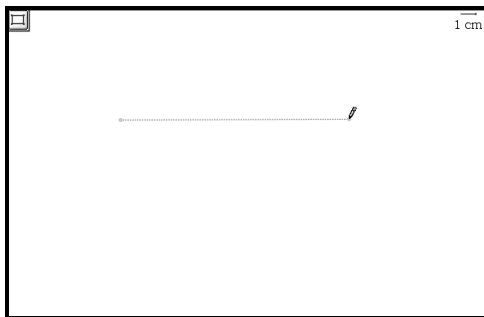
Reshaping a triangle

1. Click one of the three vertices.
2. Move the selected point until the triangle is the correct size.

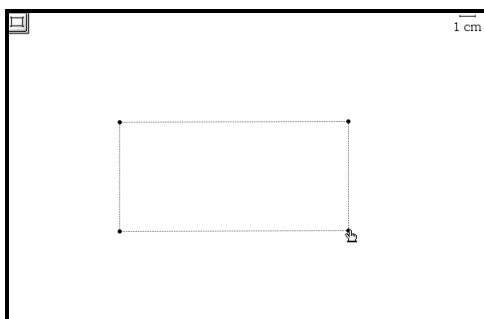
Creating a rectangle

1. From the **Shapes** menu, select the Rectangle tool .
- Press   .
2. Click once to establish the first corner of the rectangle.
3. Move the cursor to the location for the second corner, and click again.

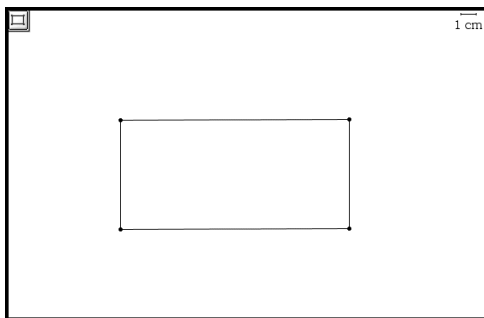
One side of the rectangle is defined.



4. Move the cursor away perpendicularly from the side to the line. The outline of the rectangle appears on the screen.









5. When the rectangle is of the correct size, click again to anchor the rectangle to the work area.

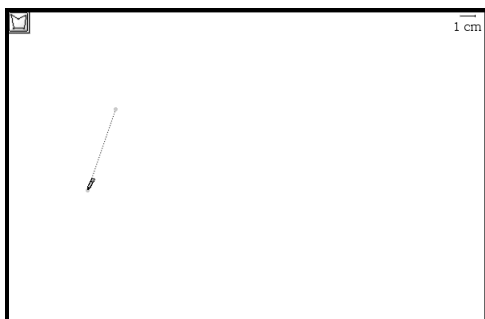


Creating a polygon

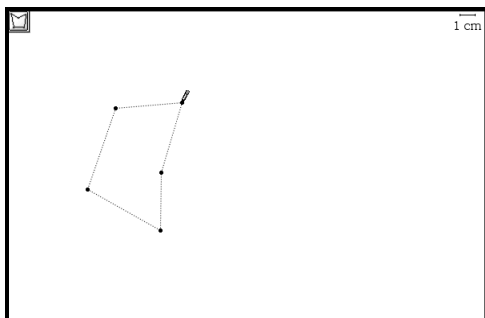
You can create a polygon by defining three or more connected points.

While you can create a triangle using the Polygon tool , using the Triangle tool  reduces keystrokes. To construct a polygon:


1. From the **Shapes** menu, select the Polygon tool .
Press   .
2. On the work area, click once to establish the first point of the polygon.
3. Move the cursor to the location for the second point and click again.
Notice that the side of the polygon is shown as a dotted line.



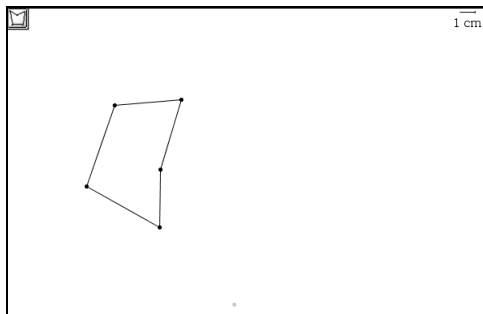
4. Move the cursor to the location of the next point.
As you move the cursor, the polygon's sides display as dotted lines.
Continue to move the cursor and click to create as many sides as needed.



5. To complete the polygon and anchor it on the work area, do one of the following:


- double click the final point,
- click on the initial point, or
- press .

The sides are defined by solid lines.



Note: If you create a polygon with all defined points colinear, then the construction is defined as a segment.

Moving a polygon




1. Select the Pointer tool .
2. Select one side of the polygon.
3. Drag it to the new location.

Reshaping a polygon

1. Select one of the vertices.
2. Drag it to a new location.
3. Click to re-anchor it on the work area.

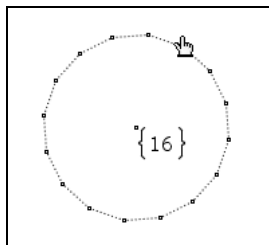
Creating a regular polygon

1. From the **Shapes** menu, select the Regular Polygon tool .

Press   .

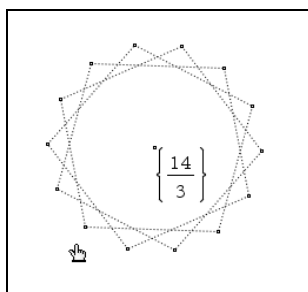
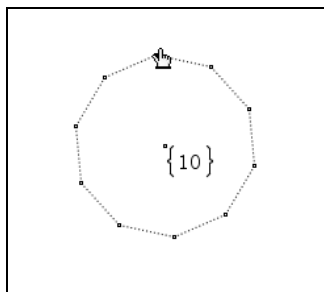
2. Click once on the work area to establish the center point of the regular polygon.
3. Move the cursor away from the center point and click on the work area again to establish the first vertex and radius.

A 16-sided regular polygon is formed. The number of sides displays near the center point in brackets; e.g., {16}.

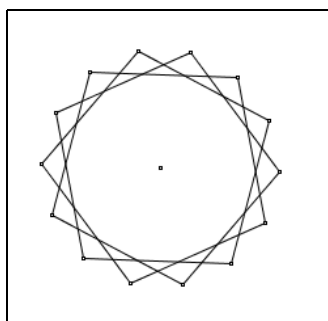


- To reduce the number of sides, select a vertex and move the pointer in a clockwise motion around the perimeter of the polygon.
- To increase the number, select a vertex and move the pointer in a counter-clockwise motion.

Note: The number of sides of the polygon displays as you move the pointer.



4. When the desired number of sides displays, click to anchor the polygon on the work area.






Anchored regular polygon

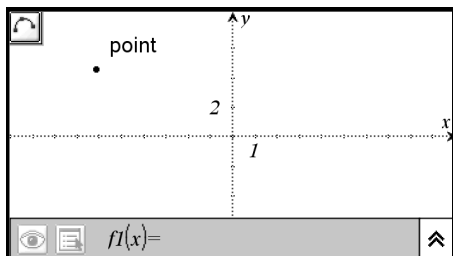
Creating a circle arc

You can create a circle arc by defining three points on the arc.

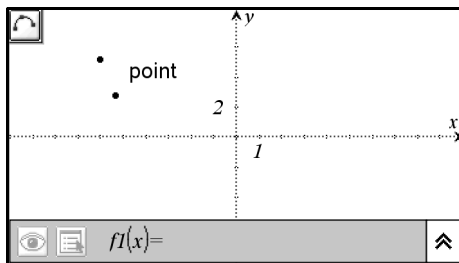
1. From the **Points & Lines** menu, select the Circle arc tool .

Press   .

2. Click once on the work area to establish the first point of the arc.

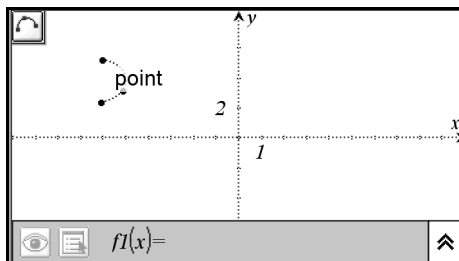


3. Move in the direction you want the arc to take and click on the work area again to establish the second point.







4. Move away from the second point to establish the length of the circle arc and click on the work area a third time.

An arc is formed.



Transferring Measurements

You can duplicate (transfer) a specific length to a new object using the Measurement Transfer tool .

Press   .

The objects you can transfer a length to are:

- a circle - the length transferred becomes the radius of the circle. You can also transfer a measurement onto a circle to define an arc.
- a ray - the length transferred starts at the endpoint and defines a second point on the ray.
- a vector - the length transferred starts at the endpoint and defines a second point on the vector.

You can also transfer a numeric text value to an axis.




Transferring a measurement

1. Measure and display the length or area that you want to transfer.

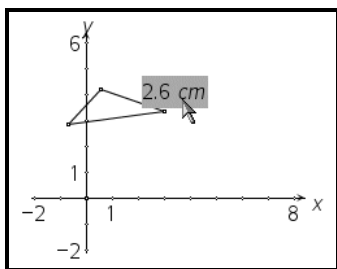
If you want to transfer the measurement to a ray or vector, create these objects if they do not already exist on the work area.


2. From the **Construction** menu, select the Measurement Transfer tool






Press   .

3. On the work area, select the measurement value you want to transfer to a new object.



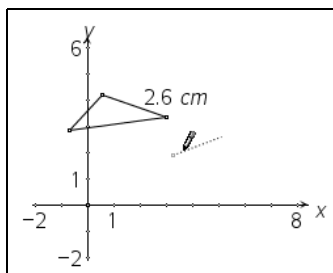
4. To create a circle, select the Circle tool 

Press   .

- a) When you move to the work area, the circle immediately appears. Its radius is the transferred measurement.

- b) Click to anchor the circle on the work area.
5. If you are transferring a measurement to a line, ray or vector, click on the object.

The distance between the two defined points is the transferred measurement.



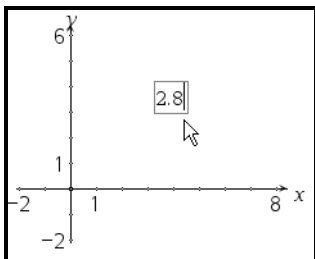
Ray created from the transferred measurement

Note: If you adjust the length of the initial measurement, all objects you create with that measurement are adjusted automatically to reflect the change.

Transferring a numerical text entry to an axis

1. Using the Text tool , create the number on the work area.

Press .



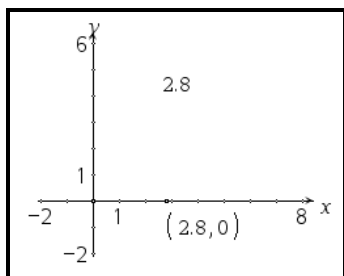
2. From the **Construction** menu, select the Measurement Transfer tool




Press .




3. Select the created number, then click on the desired axis.

The value is marked by the addition of a point on the axis. In the example below, this point is labeled to show its value.






Transferring a measurement onto a circle

1. Either enter a value using the Text tool , or display a measurement on the work area.

Press   .

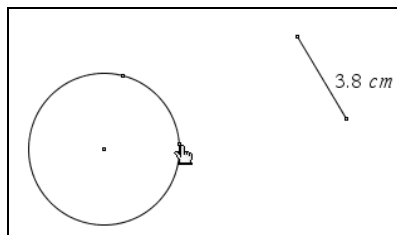
Create a circle using the Circle tool if one does not already exist on the work area.

2. Select the Measurement Transfer tool .

Press   .

3. Select the value and the circle.
4. Click on the circle a second time to define the starting point for the transferred measurement.

The measurement is transferred in a counter-clockwise direction, and the starting and ending points of the value are marked by points. The arc defined on the circle has the same measure as the transferred value.



The segment length was transferred onto the circle. The two points on the circle define this length. The hand cursor shows the starting point for the transfer.

Note: If you measure the distance between the two points on the circle, the value will be less than the transferred measurement. The straight line between the points is measured, not the arc formed between the two points. The arc's length is the transferred measurement.

Measuring graphs and objects

You can obtain various measurements from the functions you graph and the objects you draw. These measurements include finding areas, perimeters, lengths, angles, and slopes. The metric system is the default for units of measurement.

Note: Document settings are available under the **File** menu.

Identifying equations for circles and lines

You can display the equation of any Analytic object (constructed in the Graphing View, or within the Analytic Window of the Plane Geometry View) and label it on the screen. To do this:

1. On the work area in Graphing view, create a circle or line.
2. From the **Actions** menu, select the Coordinates and Equations tool

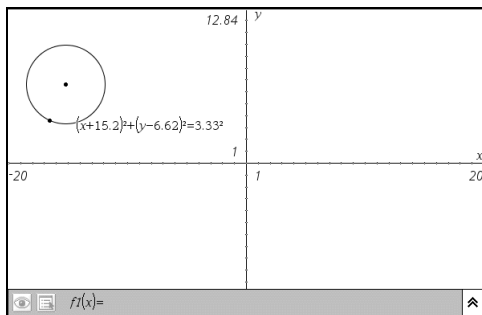


Press .

3. Click or press to select the circle or line.

The equation for the circle or line displays and the object blinks on the screen.

4. Click or press to anchor the equation on the screen.






Note: If you approach a defined point on the line or the center point of a circle, the coordinates for that point display instead of the equation. Move the cursor away from the defined point to obtain the equation of the object.

Measuring length


You can use the Length tool to measure the length of a segment, circle arc, or vector. The length tool can also measure the distance between two points, the distance from a point to a line, ray, segment, or vector, and the distance from a point to a circle.

Note: Measurements made on Graphing view objects and lines have generic units, u. Measurements made on Plane Geometry view objects and lines have the unit value you create. The default unit value is centimeters (cm).


1. From the **Measurement** menu, select the Length tool .

Press   .

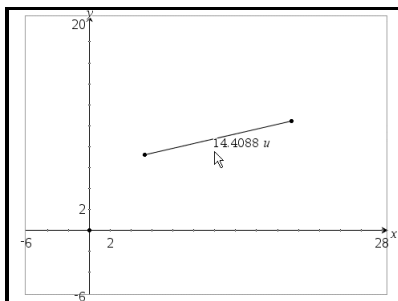
2. To measure a segment, circle arc, or vector:

- a) Click or press  to select the object.

The target segment, circle arc, or vector blinks.

- b) Click or press  to anchor the measurement on the work area.

Note that a line segment can be part of a triangle, rectangle, or polygon.

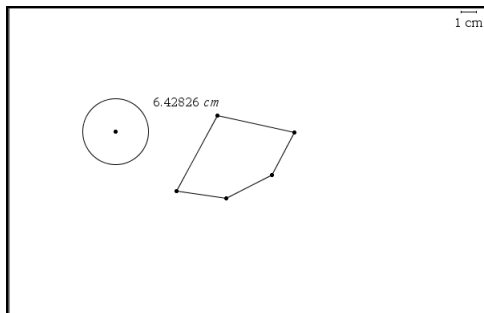


3. To measure the distance between two points, between a point and a line, or between a point and a circle:

- a) Select the first point.
- b) Select the second point or a point on the line or circle.


The selected length blinks.

- c) Click or press  to anchor the value on the work area.



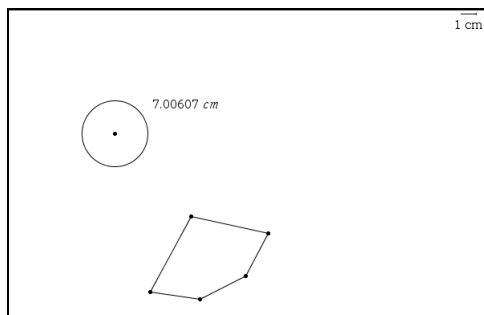
In this example, length is measured from the center of the circle to the upper left vertex of the polygon.

4. To measure the length of one side of a triangle, rectangle, or polygon:

- a) Select each endpoint of the segment.
- b) Click or press  to anchor the value on the work area.







Note: The value that displays when you initially approach the object (before selecting the endpoints of the side) is the perimeter of the object, not the length of the one side.

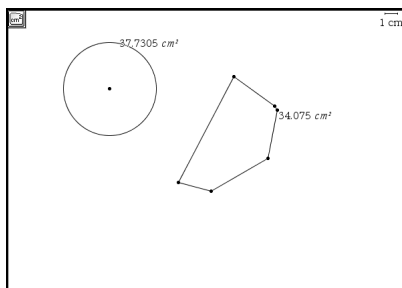
The measurement remains visible and close to the measured objects even if you move one or both of the objects or measurement points. If you move an object or point, the measurement updates to reflect the new distance.



Polygon moved on work area. Note the distance value reflects new distance.

Finding the area of a circle, polygon, rectangle or triangle







1. From the **Measurement** menu, select the Area tool . Press   .
2. On the work area, click or press  to select the object.
3. To anchor the value on the work area, click or press .

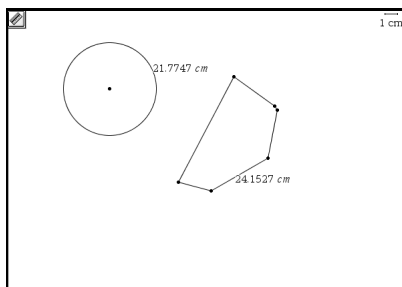


The area of the circle and the polygon are shown in this example.

The measurement remains visible and close to the object even if you change the size of the object. If you alter an object, the measurement updates to reflect the new area value.

Finding the perimeter of a circle, polygon, rectangle or triangle





1. From the **Measurement** menu, select the Length tool .
Press   .
2. On the work area, click or press  to select the object.
3. To anchor the perimeter value on the work area, click or press .



The measurements in the example are the perimeters of the circle and polygon.

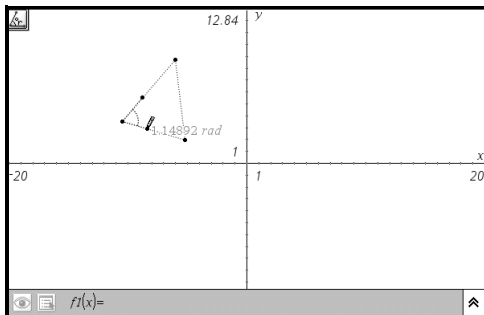
The measurement remains visible and close to the object even if you change the size of the object. If you alter an object, the measurement updates to reflect the new perimeter value.

Finding the measure of an angle

1. From the **Measurement** menu, select the Angle tool .
Press   .
2. Click on a point on one side of the angle to be measured.

- Click on the vertex of the angle you want to measure.


When you move the cursor away, the measure of the angle displays near the second point clicked.






- Click on a point on the second side of the angle to be measured to anchor the value on the work area.

Defining an angle with three points


You can define and measure an angle by selecting three points on the work area.

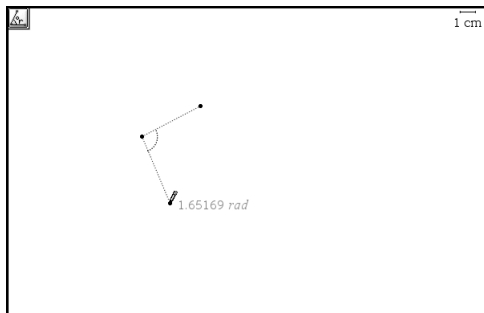
- From the **Measurement** menu, select the Angle tool .

Press   .

- Click once on the work area. The first click represents one side of the angle. As you move to the next point, a dotted line shows the path used for angle measurement.
- Click a second time on the work area. The second click represents the vertex. As you move to the next point, Graphs & Geometry calculates the measurement of the angle and displays it on the work area.

If you are defining an angle with a specific measurement, you can change the path to adjust the angle size.

- Click a third time on the work area or press . The third click represents the second side of the angle and anchors the three points as defined.






The measurement remains visible and close to the angle even if you change the size of the angle. If you alter the angle, the measurement updates to reflect the new value.

Notes:

- The value of any angle will always be between 0° and 180° in degree mode or between 0° and π in radian mode.
- The default angle measure is in radians. To change it to degrees or gradians, change the document settings.
- You can increase the precision of the angle measurement by placing the pointer on top of the measurement and then pressing + or - to increase or decrease the number of displayed digits.


Repositioning a measured value




1. Select the Pointer tool .



Press   .

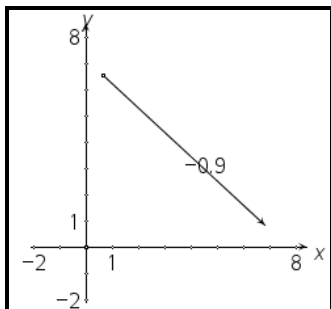
2. Select and drag the measurement to the desired location.

Finding the slope of a line, ray, segment or vector

1. From the **Measurement** menu, select the Slope tool .

Press   .

2. On the work area, click or press  to select the object.
3. Click or press  to anchor the value on the work area.



The slope remains visible and close to the object even if you alter the slope. Note that the value changes as the object is moved.

Note: If the object is vertical, the slope value is $-\infty$ or $+\infty$. If the object is horizontal, the slope value is 0.

Adding text to the work area

You may want to add your own text to a page or enter a numerical value to use on the work space. Graphs & Geometry enables you to do this using the Text tool

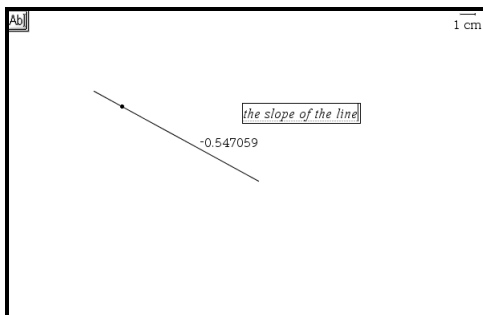
1. From the **Actions** menu, select the Text tool .

Press .

2. On the work area, select the location for adding text, and click .

A blinking cursor appears at the spot you selected.

3. Type the text.



You are limited to typing the text that will display on the page.

If you use the Text tool $\boxed{\text{Ab}}$ to enter numerical values, these are interpreted as numbers by Graphs & Geometry and can be used for computing or specifying measurements.

- Click again or press enter to anchor the text on the work area.

To exit this mode, select another tool or save your work.

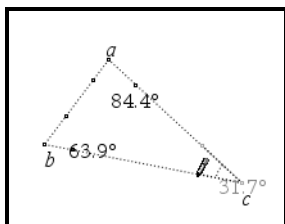
Moving text

- Select the text with the Pointer tool mouse .
- Drag it to the new location.
- Click the text to anchor it in the new position.

Using the Calculate tool

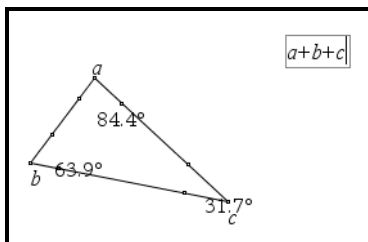
The Calculate tool $\boxed{\text{a+b}}$ enables you to perform arithmetic calculations using measured and entered values. An example best shows how this tool is used.

- Create an object and display measurements for it. In this example, a triangle is constructed and its angles are measured.






- Use the Text tool $\boxed{\text{Ab}}$ to write the desired formula. Here, the angle measurements are added.

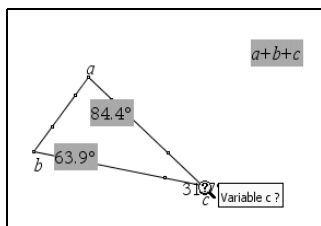
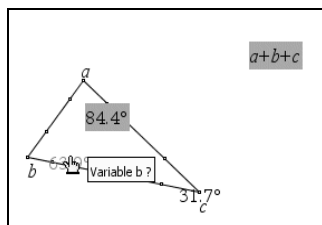
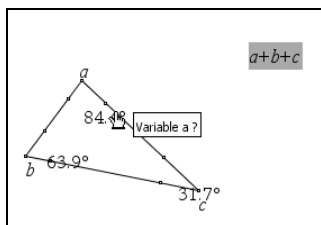
Press menu $\langle 1 \rangle$ $\langle 5 \rangle$.



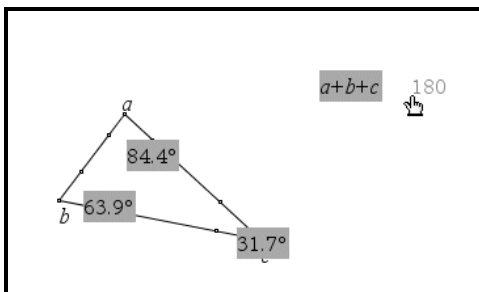
- Select the Calculate tool $\boxed{\text{a+b}}$.

Press   .

Select the formula just created, then select each angle measurement.







4. When all variables in the formula have values, the answer displays on the work area.
5. Click to anchor the value.



Exploring functions, graphs, and objects

Once you create graphs and objects, you can use other tools to explore various relationships among and between them.

Finding points of interest: zeroes, minima, maxima

When you create a graph, you can use the Point On tool  (press   ) to locate the zeros, minima, and maxima if these are applicable for objects on the work area. (They may not display if their location on the graph not visible on your screen.) Both local and global points of interest display. You can also use the Graph Trace tool to display the local points of interest automatically as you trace.

Note: Global points of interest display only when they are also local. For example, inverse sine reaches its (global) maximum at $x=1$, but the tool tip 'M' does not display there. This is because $x=1$ is not a local maximum.




To find them, just move the point along the object or graphed line, and when you are near a point of interest, the coordinates display along with one of the following identifiers:

- Zeroes: z (Coordinates)
- Minimum: m (Coordinates)
- Maximum: M (Coordinates)


Finding the min and max of a function




To find the minimum or maximum of a function or object on the graph:

1. From the **Points & Lines** menu, select the Point On tool .

Press   .

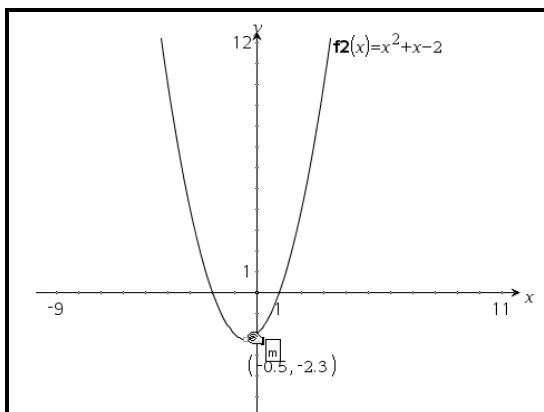
2. Select the function graph or object.

3. From the **Actions** menu, select the Pointer tool .

Press   .

4. Select the point created in Step 2 and drag it along the function graph or object.




As you approach a point of interest, the one-character identifier along with the point's coordinates display. The example below shows the m (minimum) identifier along with the value of the minimum for the function graphed on the axes.



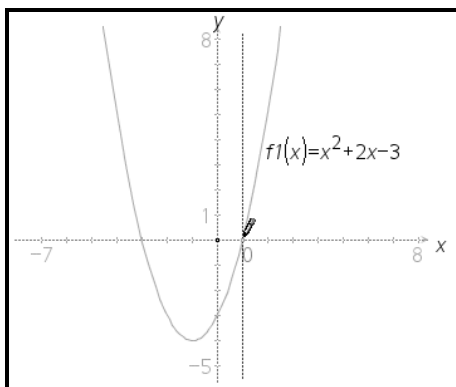
- As you move away from the point of interest, the identifier no longer displays on the page.

Finding the definite integral of a function

- Select the function.
- From the **Measurement** menu, select the Integral tool .

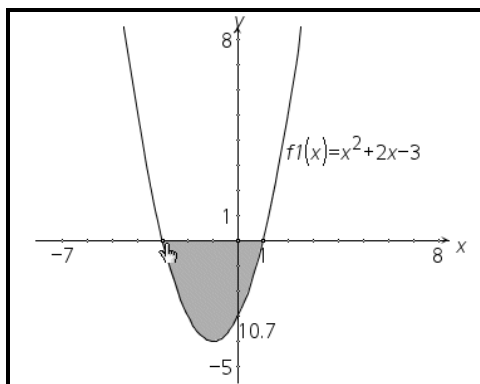
Press   .

- Define the range for the integral, both the upper and lower limit. Do this by clicking on the function to display a limit boundary line.



- When the boundary line is in the desired location, click to anchor it on the page.
- Move the cursor to display the second limit boundary line.
- When it is correctly located on the page, click to anchor it.





Notice that the integral between the bounds and with respect to the x-axis is shaded on the page.

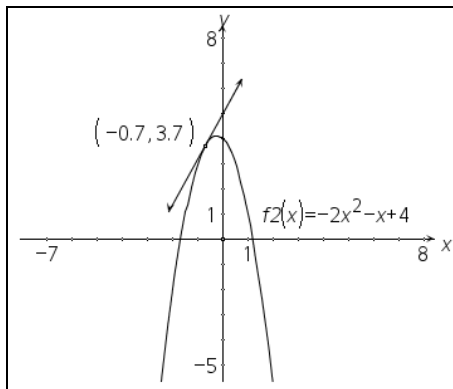


Tips:


- To stop the boundary line at a tic mark on the x-axis, select the tic mark.
- For precise integral boundaries, type a numerical value instead of graphically placing either or both lower and upper boundary lines.




Finding the derivative of a function at a point (the slope)

1. Graph a function.
 2. Select a point on the graph.
 3. From the **Points & Lines** menu, select the Tangent tool .
- Press   .
4. Construct the tangent at this point.

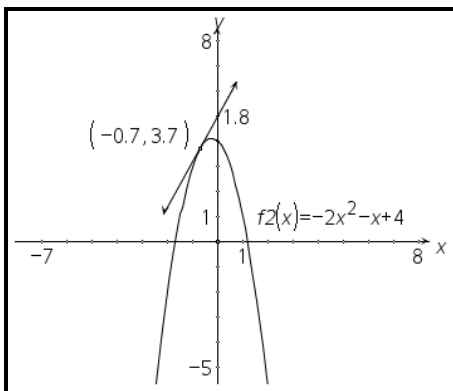


Tangent line created for the function. The point of tangency is labeled.

5. From the **Measurement** menu, select the Slope tool .

Press   .

6. Determine the slope at the tangent.
This is the value of the derived function for the selected value of x .
7. Click to anchor the value on the page.



Transformations

You can apply transformations to drawn objects, and some can be applied to functions. When working with functions, the axes are most frequently involved and may be required. Object transformations can occur without the use of axes as a reference point.


The transformations supported by Graphs & Geometry are:




- Symmetry with respect to any point, including the origin

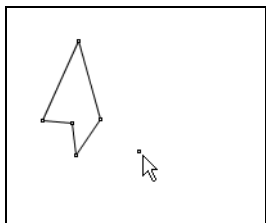
- Reflections with respect to any straight line, including the axes
- Translations along any vector, including vectors on the axes
- Rotations about any point, including the origin, and any angle
- Dilations from any point, including the origin, with any factor

The first step in any transformation is to create an object or the graph of a function.




Exploring symmetry

1. Create an object or graph a function.
2. Create a point of symmetry using the Point tool .

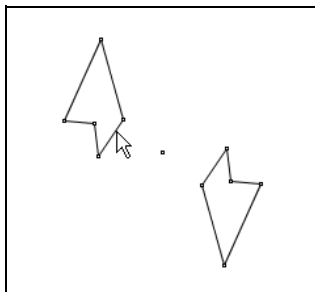
Press   .



3. From the **Transformation** menu, select the Symmetry tool .

Press   .




4. Select the object, then select the point.
5. The symmetrical image displays.



Exploring reflection

1. Create an object.
2. Create a line or segment about which the object will be reflected.

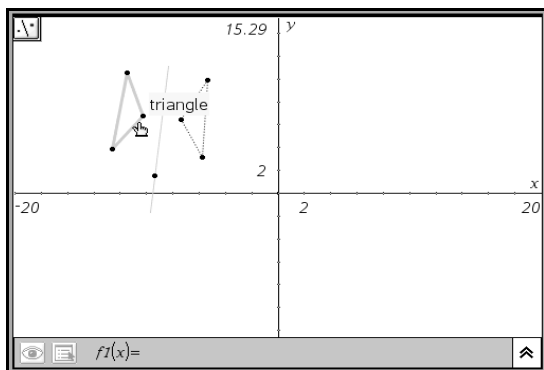
3. From the **Transformation** menu, select the Reflection tool .


Press   .

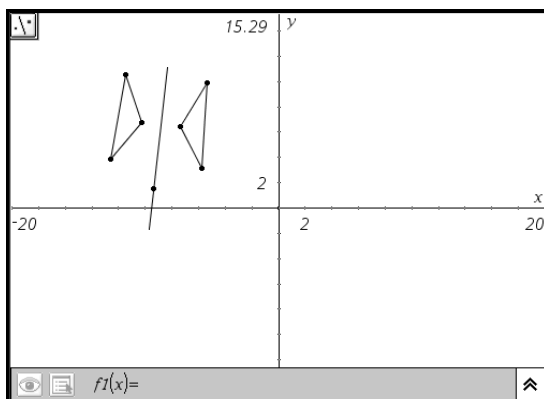
4. On the work area, select the reflection line or segment.

5. Select the object.

The object reflection displays on the page.



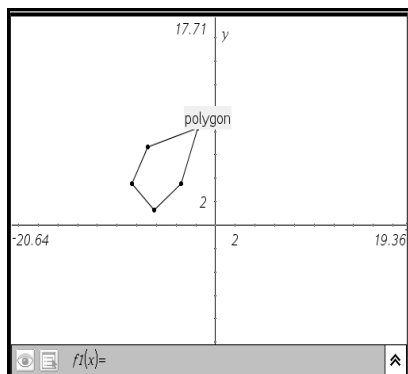
6. To anchor the reflection, click on the page or press .






Exploring translation

1. Create an object to translate (duplicate).
2. You can define the distance and direction of translation by
 - creating a vector, or
 - selecting two points "on the fly".

To use a vector, define it before performing the translation. The examples use two points to define translation distance and direction.



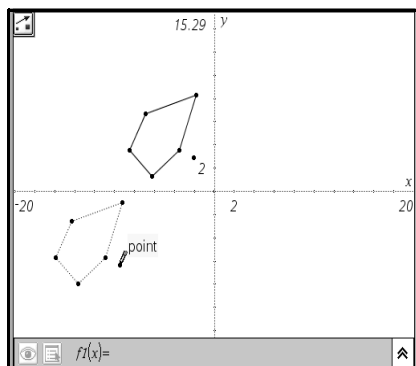
3. From the **Transformation** menu, select the Translate tool .

Press   .

4. Select:

- the vector or click on the page to define the translation direction and distance
- the translation object.

The translated object displays.



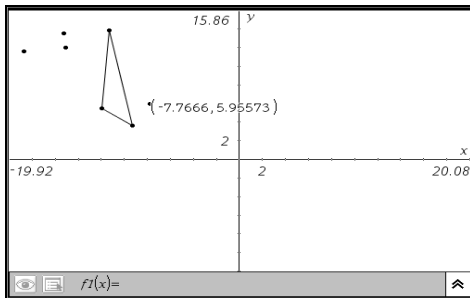
Exploring rotation

1. Create an object or graph a function.
2. Create a point about which the object will be rotated.

3. Create three points whose angle defines the angle of rotation, or using the Text tool **Abj**, type a numeric angle value.

Press **(menu)** **1** **5**.

4. Press **(enter)** to anchor the value on the work area.



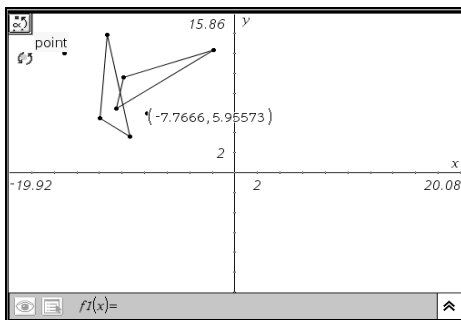
Triangle ready for rotation. The rotation point is labeled with coordinates. The three angle of rotation points appear above the triangle.

5. From the **Transformation** menu, select the Rotation tool **(R)**.

Press **(menu)** **A** **4**.


6. Move to the work area and select
 - a) the point about which the object will be rotated, and
 - b) the object to rotate, and
 - c) the three points that define the angle of rotation or the numeric angle value.





The object is recreated in the rotated position as defined by the rotation point and angle of rotation.



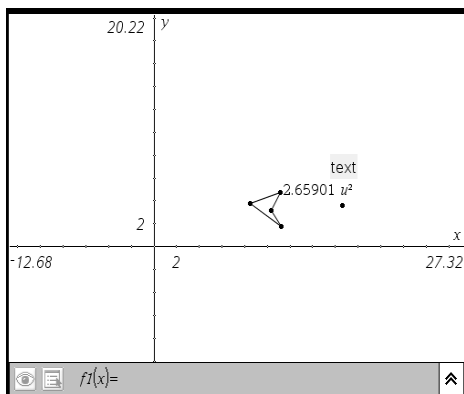
Exploring dilation

1. Create an object.


2. Create a point that is the center of the dilation.
3. Create a number using the Text tool  or measure an existing length.




Press    and press  to anchor the value on the work area.

Note: If you type a large number, the dilated object will not display on the work area without panning.



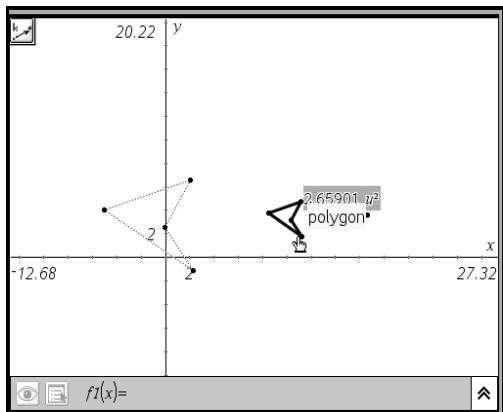
Polygon, dilation point, and measurement on page.

4. From the **Transformation** menu, select the Dilation tool .

Press   .




5. Select the value measured or created, the dilation point, and then move toward the object.

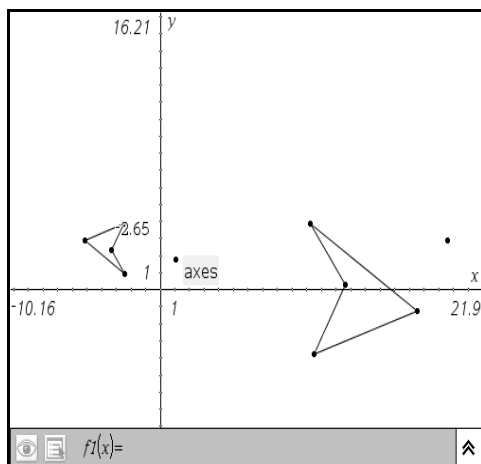
The dilation appears on the work area.



In the following example, the polygon from the previous example was retained, but a negative number was entered using the Text tool

.

Press   .



Other investigations




You can investigate graphs by

- Bisecting segments
- Bisecting angles
- Finding the Locus

Bisecting a segment defined on a line

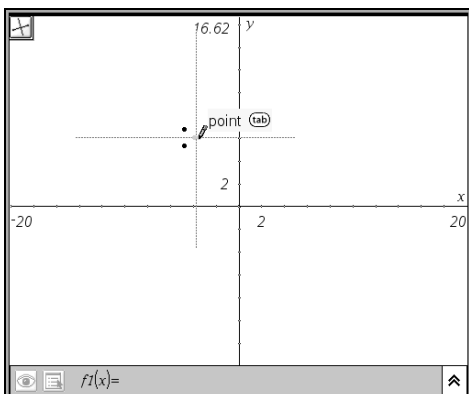
1. From the **Construction** menu, select the Perpendicular Bisector tool

.

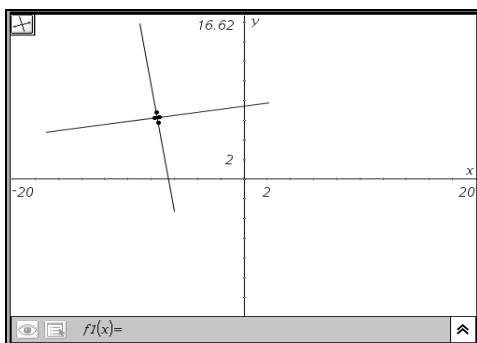
Press   .

2. Click on the line to select one end point for this segment.
3. Move to another point on the line and select it.

The segment is now defined, and the perpendicular bisector is drawn.



Creating the second point on a line.



Perpendicular bisector anchored on segment between two defined points.

Bisecting a segment

1. From the **Construction** menu, select the Perpendicular Bisector tool



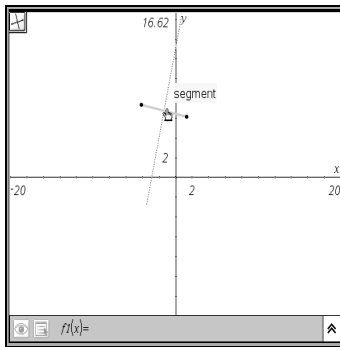
Press **(menu)** **(9)** **(3)**.

2. Click the segment.

The perpendicular bisector displays.

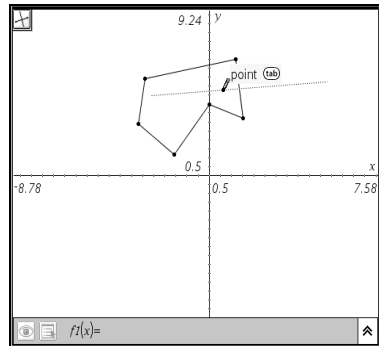
3. Click once more to anchor the bisector on the work area.

Note: A segment can be one side of a triangle, rectangle, or a polygon.



Bisecting an existing segment (bisector not anchored on page).

Bisecting the side of a polygon (bisector not anchored on page.)



Bisecting an implied segment

1. From the **Construction** menu, select the Perpendicular Bisector tool

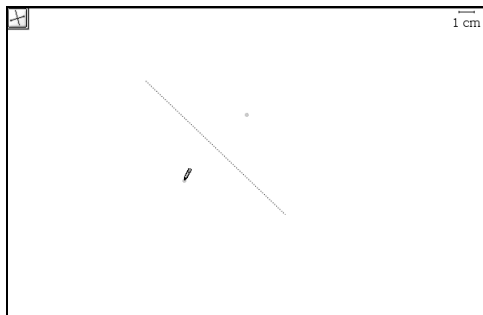


Press (menu) 9 3.

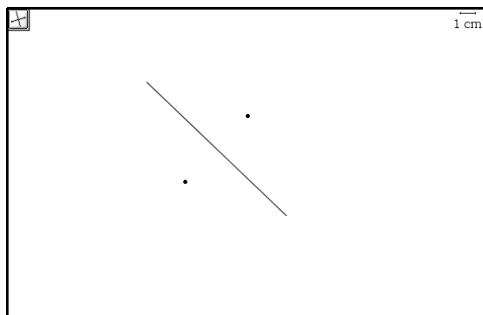
You imply a segment by defining two points.

2. Click once to define one end of the implied segment.





As you move away from this point, a segment and the bisector appear.

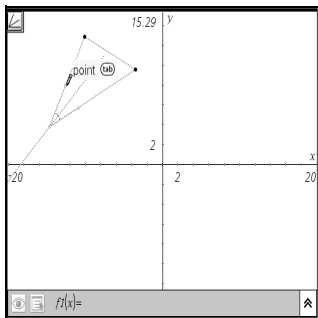


3. Click a second time to define the other end of the implied segment and anchor the segment and bisector.

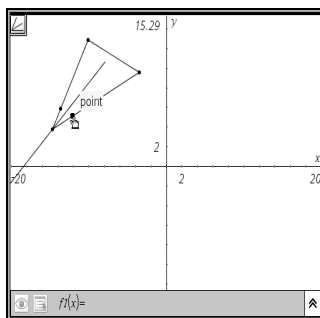


Bisecting an angle

1. From the **Construction** menu, select the Angle Bisector tool .
Press   .
2. If a triangle or other angle already exists on the work area, click once on one side of the desired angle.
3. Click once on the vertex.
4. Click once on the second side of the angle.
The bisector is anchored on the work area.







Creating the angle bisector at the vertex of a triangle.



Anchoring the angle bisector on the page.

Bisecting an implied angle

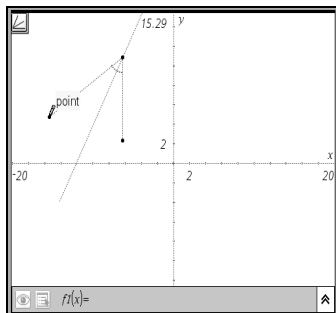
1. From the **Construction** menu, select the Angle Bisector tool .

Press   .

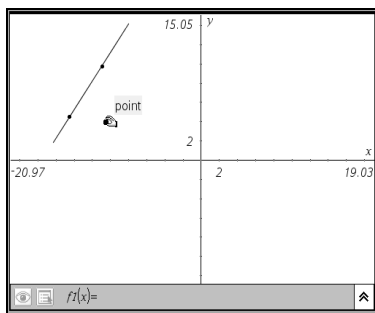
If no angle is present on the work area, you can create one by selecting three different points.

2. Click to define the first side of the angle.
3. Click to define the vertex of the angle.
4. Click to define the second side of the angle.


The bisector line appears and is anchored on the work area when you select the third point.






Creating an angle bisector by defining three points. The second point represents the vertex of the angle.




Angle bisector created by defining three points on the page.

Note: If you select the Pointer tool  and move one point of the created angle, the angle bisector moves so that it always bisects the angle.

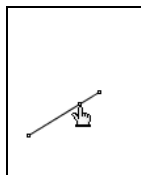
Press   .

Creating a locus

The Locus tool  enables you to explore the range of motion of one object with respect to another object as constrained by a shared point.

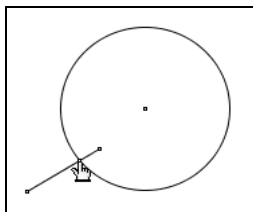
To create a locus:

1. Create a segment, line, or circle.
2. Create a point on the segment, line or circle.







Point defined on the line segment.

3. Create another object that uses the defined point created in the previous step.



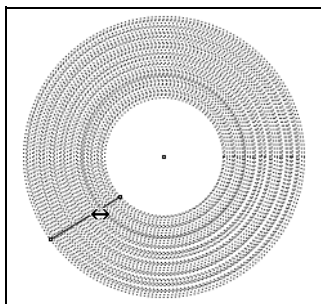
Circle created to use the defined point on the segment.

4. From the **Construction** menu, select the Locus tool .

Press   .

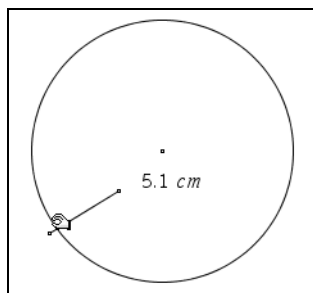
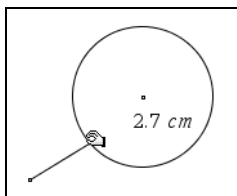
5. On the work area, select the last object.
6. Select the defined point used by both objects.

The continuous locus picture is displayed.



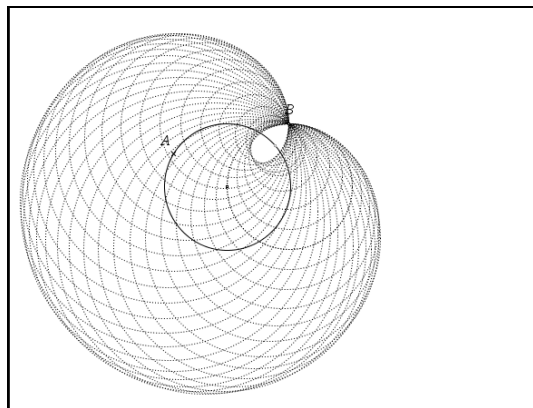
7. Move the point on the first construction.

The second construction deforms to follow the locus point.



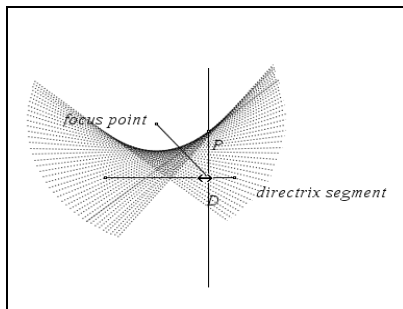
Two examples of the radius change of the circle as the locus moves along the line segment. The radius is labeled to better show the change.

You can create and explore a large number of designs using the Locus tool and your imagination. The following are examples of a few structures that you can create.



Locus created from two overlapping circles.

Locus created using a point and a segment.






Animating objects

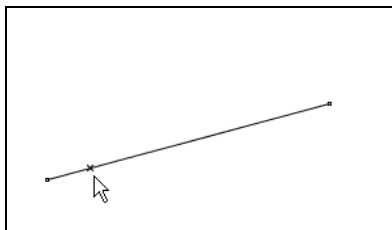
You can animate a point on a line, ray, axis, vector, graph, segment or circle. In addition, you can also animate points on multiple objects in the work area at one time.


Animating one point on an object




1. From the **Points & Lines** menu, select the Point On tool .


Press   .

Click on the object to identify the point that you want to animate.



- From the **Actions** menu, select the Attributes tool .

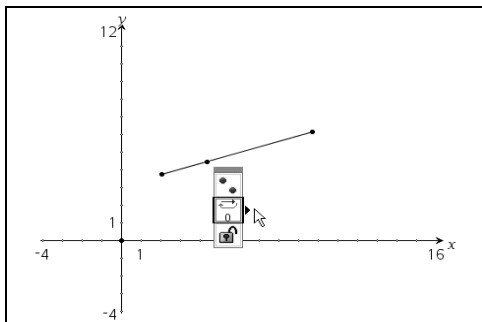
Press   .

When the attribute bar displays, select the animation attribute .



- The default speed is 0. You can type a number from 1 - 9 to set speed or you can use < or > to select a speed from -12 to 12.

The higher the number you type, the faster the animation speed.

- Select \rightarrow for one-way animation or \leftrightarrow for oscillating animation.



- Animation begins automatically when you select the speed and direction.

Press  and  to increase/decrease the speed of animation incrementally once it is set.

The animation control panel

Once a point is animated, a floating control panel displays on the page. You can move this panel by dragging it to a new location.

When animation is active, the panel contains a **Reset**  and a **Pause**  button. When either button is pressed and animation is reset or paused, the **Pause** button changes to a **Start**  button. These controls affect all animated points on a page.







Panel when animation is active



Panel with animation paused/reset

Changing the animation of a point in motion

To change the speed of a point's movement or the direction of animation:

1. Reset or pause the animation.
 - a) Select the Attributes tool .
 - b) Select the point you want to change.
 - c) When the attribute bar displays, select the animation attribute ().
2. To change the speed, type a new velocity number.
3. To change the direction of animation, press  to select the desired direction.
4. Press the **Start**  button.


The point moves at the new speed and/or in the new direction you selected.

Pausing and resuming animation

To pause the animation on a page, select the **Pause**  button.

To restart animation, select the **Start**  button.



Resetting animation

Selecting the **Reset**  button not only pauses animation but also returns the animated point to its initial coordinate position on the object when animation was first started. If multiple points are animated on the page, all are returned to their original locations when you select Reset.

Stopping animation

To stop the animation of an object:

1. Select the **Pause**  or **Reset**  button on the control bar.
2. Display the Animation attribute for the point.

3. Change the speed to 0 (zero).
4. Click an empty area of the screen to apply the change, or press .
5. Select Start  to resume animation if other animated points were temporarily stopped.

If no other animated points are on the page, the animation control box does not reappear when the velocity is set to 0.

Note: If you have multiple points in motion on one page and want to permanently stop the animation of all objects, when motion is paused or stopped, display the attributes bar for each point and change the velocity to 0.

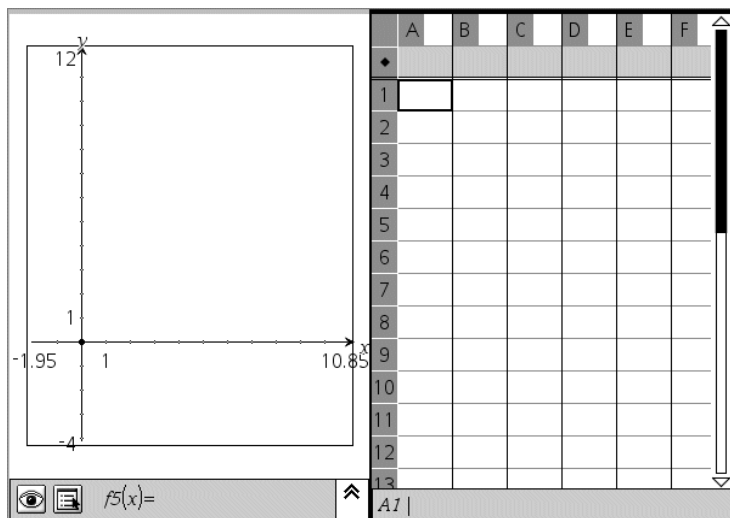
Plotting collected data

In addition to using Graphs & Geometry by itself, you can use it to explore the data collected from scientific instruments or stored in lists. Using data to create plots can be more helpful in understanding and interpreting data than just examining the raw values.

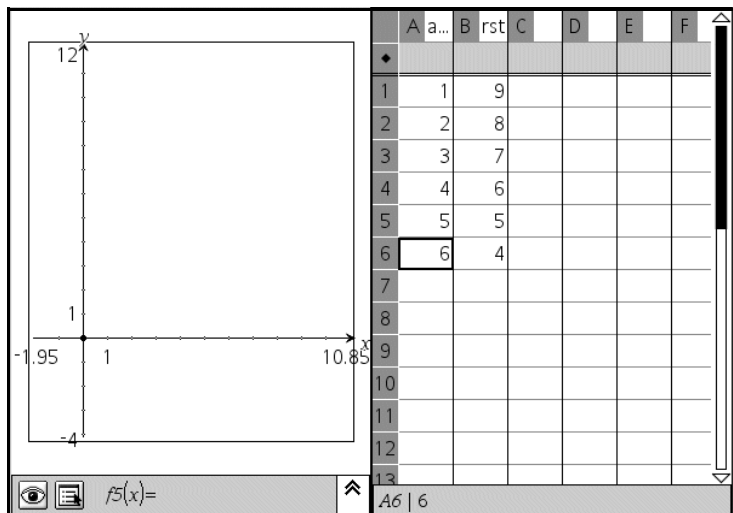
Creating a scatter plot

If you do not have an existing set of data points available for plotting, create them on the same page using the Lists & Spreadsheet application.




1. To create the data lists and scatter plot on the same page, select a page configuration with two work areas.

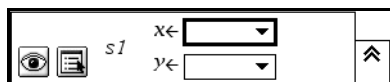


2. Create the data lists on the Lists & Spreadsheet portion of the page.

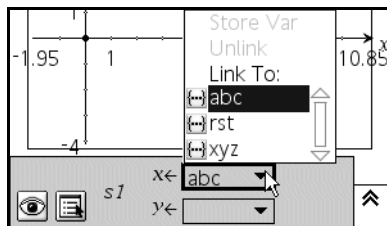


3. Select the Scatter Plot tool .

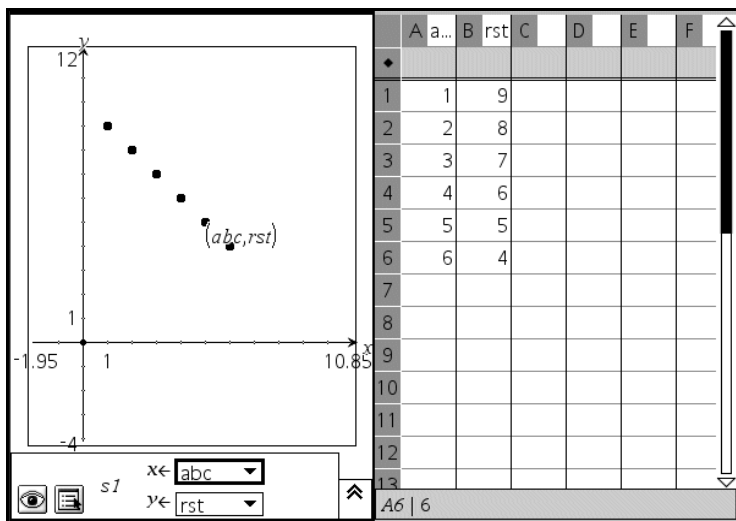
Press   .




4. Select the lists to plot from the drop down list for each axis.



When both entry fields have a data list specified, the scatter plot displays on the Graphs & Geometry work area.



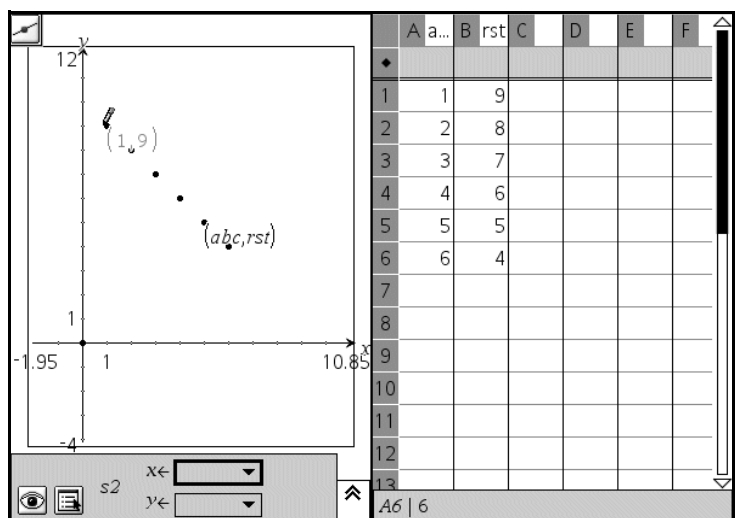
5. To label the points on the scatter plot, select the Point On tool  from the **Points & Lines** menu.

Press (menu) (6) (2).

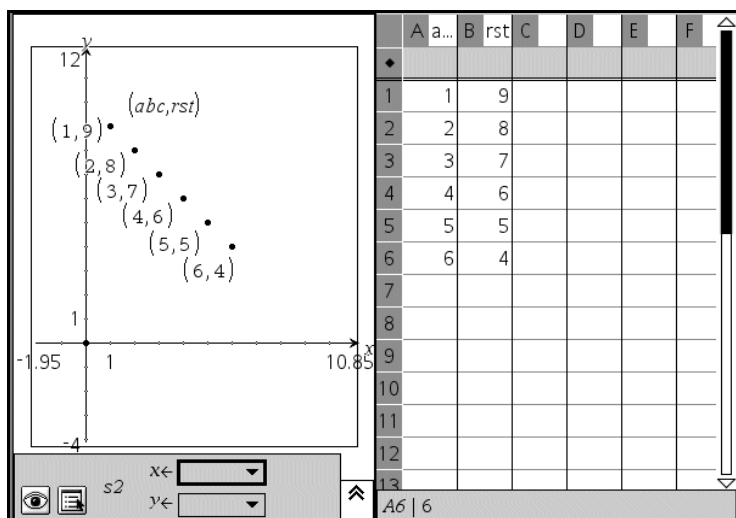
- a) Select the first point.

The coordinates display.

- b) Click to anchor the values on the work area.



- c) To label the remaining points, select them one at a time.
Click each one to anchor the coordinates on the work area.



6. Label the axes and significant points, if desired.

Note: If you have plotted more than one set of data, notice that each plot has a different point style.

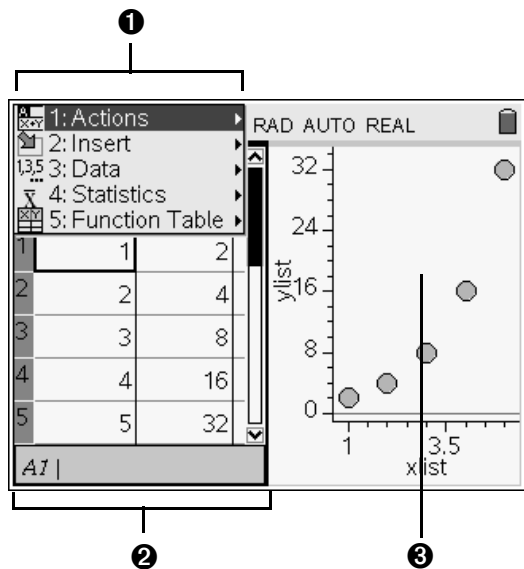
You can use Graphs & Geometry to examine the differences between points in one data set or between two or more sets by determining the slope between points, comparing min and max points, and/or calculating overall change over elapsed time.

Using Lists & Spreadsheet

Getting started with tables

The Lists & Spreadsheet application gives you a place to work with tabular data. You can use Lists & Spreadsheet to:

- Store numeric data, text, or math expressions.
- Define a table cell in terms of the contents of other cells.
- Define an entire column in terms of another column.
- Share columns of data as list variables with other TI-Nspire™ math and science learning technology applications. Also share individual cells as variables.
- Work with variables created in the Graphs & Geometry and Calculator applications.
- Collect tables of real-world data from sensors.
- Generate columns of data based on other columns or sequences that you define.
- Plot table data using the Data & Statistics application.
- Generate function tables from functions defined in Calculator or Graphs & Geometry.
- Perform statistical analysis on lists of data.









- ❶ Lists & Spreadsheet menu (available when a Lists & Spreadsheet work area is active) Press $\text{\textcircled{menu}}$ to display the menu.
- ❷ Sample Lists & Spreadsheet work area
- ❸ Lists & Spreadsheet data shared with another TI-Nspire™ application

The Lists & Spreadsheet tool menu

The Lists & Spreadsheet tool menu lets you modify your display and enter and evaluate a variety of math expressions.

Menu Name	Menu Option	Function
Actions		
	Move Column	Lets you reposition the current column.
	Resize	For a selected column, lets you set the width to maximum, minimum, or a custom width. For a selected row, lets you set a custom row height.

Menu Name	Menu Option	Function
	Select	Selects an entire row or column, or helps you insert a range of cells into a cell formula.
	Go To	Jumps to the specified cell, such as d16 or g20 .
	Recalculate	Recalculates results of all cell formulas and generates new results for random functions such as rand() , randInt() , and randSamp() .
	Sort	Lets you sort the selected columns of the spreadsheet based on the contents of a single column.
 Insert		
	Insert Cell	Inserts a cell.
	Insert Row	Inserts a row above the current row.
	Insert Column	Inserts a column before the current column.
 Data		
	Generate Sequence	Displays a dialog box for creating a sequence.
	Data Capture	Allows manual or automatic capture of variable data from Graphs & Geometry, Calculator, Data & Statistics, or within Lists & Spreadsheets. Use the following key sequence to trigger each manual capture:  

Menu Name	Menu Option	Function
	Fill Down	Lets you duplicate the contents of a selected cell or group of cells within a column.
	Clear Data	Removes data from the selected column or columns. Does not clear list names or column formulas. After the data has been cleared, column formulas are recalculated in the selected columns.
	Quick Graph	Uses the Data & Statistics application to graph one or two selected columns of data as a dot plot, dot chart, or scatter plot.
 Statistics		
	Stat Calculations	Lets you select from several statistics calculations, such as one-variable analysis, two-variable analysis, and regressions.
	Distributions	Lets you calculate and plot several distributions, such as Normal Pdf , Binomial Cdf , and Inverse F .
	Confidence Intervals	Lets you calculate several confidence intervals, such as t interval and z interval .
	Stat Tests	Lets you perform and plot several hypothesis tests such as t test , z test , and ANOVA .
 Function Table		
	Switch to Function Table	Toggles the function table view.

Menu Name	Menu Option	Function
	Select Function	Lets you select a different function for the current column.
	Edit Function Table Settings	Lets you change the viewing parameters for the table.
	Delete Column	Removes the current column.
	Edit Function Expression	Lets you change a function definition without leaving the function table.

Before you begin

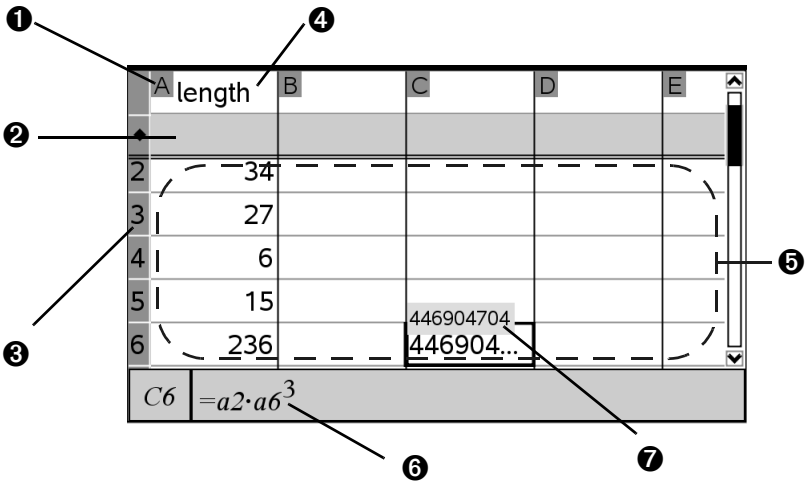
- ▶ Turn on the TI-Nspire™ handheld, and add a Lists & Spreadsheet application to a document.

Navigating in a spreadsheet

You can select any cell to view or edit its contents. When a spreadsheet is larger than the Lists & Spreadsheet work area, you can view different parts of the spreadsheet by:

- Pressing **◀**, **▶**, **▲**, and **▼** to move through the spreadsheet. This moves the selection from cell to cell and scrolls as necessary to keep the selected cell in view. You can also use the **Page up** (**ctrl** **9**), **Page Dn** (**ctrl** **3**), **Home** (**ctrl** **7**), and **End** (**ctrl** **1**) keys.
- Using the **Go To** command on the **Actions** menu to select a specific cell. Type the cell's column letter and row number (such as G16).

A column letter appears at the top of each column, and a row number appears in the left cell of each row. The top two rows and the left column of the spreadsheet remain in place as you scroll so you can more easily determine your location.



- ❶ Column reference letter
- ❷ Header or formula row
- ❸ Row reference number
- ❹ Column/list name
- ❺ Cells
- ❻ Entry line
- ❼ Result tooltip for large result


Inserting a cell range into a formula

The Select Range feature lets you insert a cell range (such as a1:b3) into a formula by selecting the range instead of typing cell addresses into an argument.


Suppose you want to calculate the mean of a range of cells.

1. Type `=mean(` in the cell that will contain the result.


	A	B	C	D
◆				
1		2	7	
2		3	8	
3		4	9	
4		5	10	=mean()
5				
	D4	=mean()		

- Press  to display the Lists & Spreadsheet menu.
- On the **Actions** menu, choose **Select**, and then choose **Select Range**.
A dotted selection rectangle appears around the cell that contains the formula.

	A	B	C	D
◆				
1		2	7	
2		3	8	
3		4	9	
4		5	10	=mean()
5				
	D4	=mean()		

- Move to the first cell in the range, and use the arrow keys along with  to select the range of values whose mean you want to calculate. The dotted selection rectangle moves to enclose the cells you specify for the range.
The formula is updated as you select.

	A	B	C	D
◆				
1		2	7	
2		3	8	
3		4	9	
4		5	10	=mean(a1:b4)
5				
D4	=mean(a1:b4)			






5. Press  twice to complete the formula and evaluate the formula and display the result.

	A	B	C	D
◆				
1		2	7	
2		3	8	
3		4	9	
4		5	10	6
5				
D4	=mean(a1:b4)			



Methods of entering data

The method you use to enter spreadsheet data depends on the type of data and your personal preferences. You can use different methods in combination.


- For simple math expressions and formulas such as $=a3 \cdot \text{length}^2$, press the corresponding keys on the handheld keypad. In this example, press = A 3 \times L E N G T H ^2 .
- For text or categorical data, type the opening quote (press ") to distinguish a string of character data. The closing quote is added automatically.

- For more complex math expressions such as $\sum_{n=1}^5 \frac{1}{n}$ press  to display the Catalog of all system functions, commands, symbols, and expression templates.
- To display only the list of templates, press  .
- To display only the list of symbols, press  .

Entering a math expression, text, or spreadsheet formula

1. Select the cell in which you want to enter data. Double-click the cell or press  to put the cell in edit mode.
2. Use the handheld keypad, the Lists & Spreadsheet tool menu, or the catalog to enter the data. You will see the text or formula in the cell and on the entry line simultaneously.
3. Press  to complete the entry and move down to the next cell.

– or –

Press  to complete the entry and move right to the next cell.

Lists & Spreadsheet automatically recalculates any cells that are dependent on the cell you entered. If you have shared the cell, and other TI-Nspire™ math and science learning technology applications are linked to the cell, the other applications are also updated.

For details on entering math expressions, refer to the Calculator section.

Working with individual cells

Creating absolute and relative cell references

Cell references let you enter formulas that refer to spreadsheet data instead of having to duplicate it and remember to update it. When you change the contents of a referenced cell, all references to the data are updated automatically in the spreadsheet.

Anytime you want to update all references and formula results in the spreadsheet, you can select **Recalculate** from the **Actions** menu.

Note: Using **Recalculate** from the **Actions** menu is also handy for getting new random numbers from the **rand** function.

Cell formulas begin with the = symbol. You refer to a cell by using its column letter and row number. Entering =3*C4 as a formula, for example, creates an expression that is 3 * the contents of the cell at column **C**, row **4**.

	B	C	D	E	F
1			2		
2			2		
3			87		
4			12	36	
5			13		

D4 =3*c4

① ②

- ❶ Formula containing a cell reference entered in cell D4
- ❷ Result of formula (3*12=36)

You can refer to a rectangular block of cells in a formula by entering the location of the upper-left cell and the lower-right cell, separated by a colon.


For example, =**mean**(B1:C5) *1. creates a result that is the mean of all cells in the block bounded by columns **B** through **C** and rows **1** through **5**. (To force the results of an expression to a decimal approximation, you multiply by "1.")

	A	B	C	D
◆				
1		12	8	
2		10	12	
3		9	11	
4		16	10	11
5		13	14	
C4	=mean(a1:b4)			

①
②

- ① Formula that refers to a rectangular block of cells
- ② Result of formula


References such as C4 and C4:E11 are *relative* references. These references describe where a cell is in relation to other cells of the spreadsheet. Lists & Spreadsheet keeps track of relative cell references. It adjusts each reference automatically when you copy or move the cell containing the reference to another location in the spreadsheet.

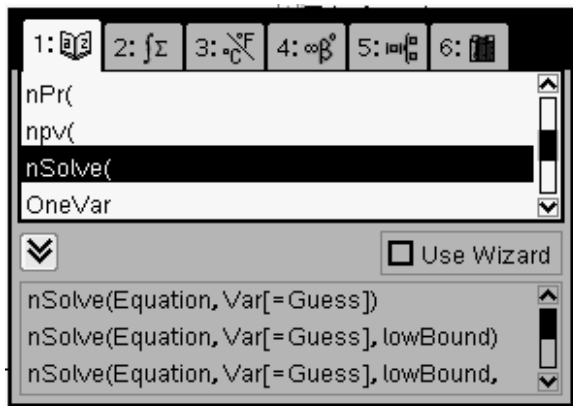
If you need a reference that always refers to a cell in a specific location in the spreadsheet, use an *absolute* reference. To create an absolute cell reference, type a \$ symbol before the column letter and row number. The \$ symbol is available in the Symbol Palette (⌘ .

For example, type \$C\$4 to create an absolute reference to the cell in column C, row 4. Lists & Spreadsheet does not adjust absolute references in a formula when you copy or move the cell containing the reference.

Inserting items from the Catalog

You can use the Catalog to insert system functions and commands, units, symbols, and expression templates into a cell formula.

1. Select the cell and type "=" to begin the formula.
2. Press  to open the Catalog.



Note: Some functions have a wizard that prompts you for each argument. If you prefer to enter the argument values directly in the cell, you may need to disable the wizard.

- Press the number key for the category of the item. For example, press to show the alphabetic list.



contains all commands and functions, in alphabetical order



contains all math functions



provides the values for standard measurement units.



provides a symbol palette for adding special characters.




contains math templates for creating two dimensional objects, including product, sum, square root and integral.












shows Public library (LibPub) objects.

- Press and then use , , , or as necessary to select the item that you want to insert.


Note: To see syntax examples of the selected item, press , and then press to alternately show or hide the Help. To move back to the selected item, press .

5. Press  to insert the item into the entry line.

Deleting the contents of a cell or block of cells

1. Press , , , or  to select the cell. (You can also hold down the  key and then press , , , or  to select a rectangular block of cells.)

	A	B	C	D	
◆					
1	10	2	1	54.3	
2	20	4	2	45.8	
3	30	6	3	4.6	
4	40	8	4	9.3	
5	50	10	5	90.1	
B2:C4					4

2. Press .


The selected cell contents are deleted.

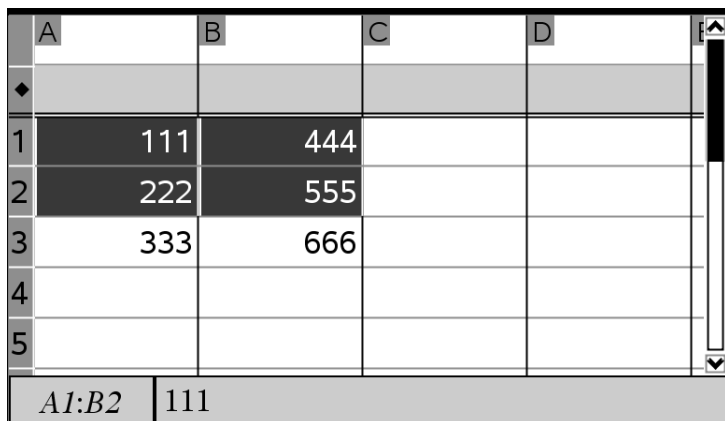
	A	B	C	D	
◆					
1	10	2	1	54.3	
2	20			45.8	
3	30			4.6	
4	40			9.3	
5	50	10	5	90.1	
B2:C4					4

Note: If other cells contain formulas that refer to the cell's previous contents, those cells show an error.

Copying a cell or block of cells



When you copy cells, the formulas (if any) in the original cells are copied to the destination cells, replacing the previous contents of those cells.

1. Press **←**, **→**, **↑**, or **↓** to select the cell. (You can also hold down the  key and then press **←**, **→**, **↑**, or **↓** to select a rectangular block of cells.)



	A	B	C	D
1		111	444	
2		222	555	
3		333	666	
4				
5				

A1:B2 111




2. Press  **C**.
The selected cell contents are copied to the Clipboard.
3. Select the cell where you want to duplicate the copied cell. If you are copying a block of data, select the cell that will become the upper left corner of the copied block.
4. Press  **V**.

	A	B	C	D
◆				
1	111	444		
2	222	555		
3	333	666		
4			111	444
5			222	555
C4:D5				

Note: Paste copied data into a cell that is in the same mode as the cell from which the data was originally copied. Otherwise, a formula could paste as a string enclosed in quotes instead of a formula.

Filling adjacent cells

You can repeat a cell's formula or value throughout adjacent cells. This gives you a quick way to fill cells with the same value or create a series of cells that contain the same formula. You can fill down within a column.

1. Select the cell whose value or formula you want to repeat.
2. Press  to display the Lists & Spreadsheet menu.
3. On the **Data** menu, select **Fill Down**.
4. Press  repeatedly to move down, selecting the range of cells that will hold the repetitions.
5. Press .

The selected cell is duplicated throughout the selected range.

Notes


- In step 1, you can select more than one cell to be repeated. If you do, make sure that you select enough destination cells to hold the repeated copies.
- If you select multiple cells in step 1 and the cells contain a simple sequence (such as 1,2,3 or 5,10,15,20), the sequence is continued in the filled area.

Sharing a cell value as a variable

You can share the value of a cell with other TI-Nspire™ applications by storing it as a variable. When you define or refer to a shared cell in Lists & Spreadsheet, the name is preceded with an apostrophe (').

1. Select the cell that you want to share.
2. Press   (or press  and select **Store Var**).

A formula is inserted into the cell with *var* as a placeholder for a variable name.

3. Replace the letters “*var*” with a name for the variable, and press .


The value is now available as a variable to other TI-Nspire™ math and science learning technology applications.

Note: If a variable with the name you specified already exists in the current problem, Lists & Spreadsheet displays an error message.

Linking a cell to a variable




When you link a cell to a variable, Lists & Spreadsheet keeps the cell value updated to reflect the current value of the variable. The variable can be any variable in the current problem and can be defined in Graphs & Geometry, Calculator, Data & Statistics, or any instance of Lists & Spreadsheet.

Note: Use caution if you link to a system variable. Linking could prevent the variable from being updated by the system. System variables include statistics results (such as *Stat.RegEqn*, *Stat.dfError*, and *Stat.Resid*) and finance-solver variables (such as *tvm.n*, *tvm.pmt*, and *tvm.fv*).

1. Select the cell that you want to link to the variable.
2. Press .

The VarLink menu displays.

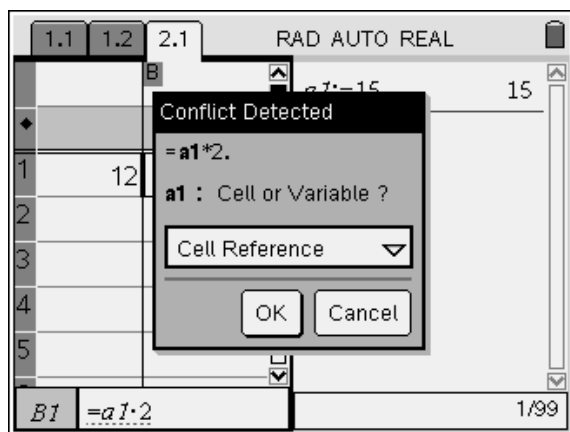


3. Under **Link To**, press , and  to scroll to the name of the variable.
4. Press .

The cell shows the value of the variable.

Preventing name conflicts

Short TI-Nspire™ variable names can conflict with the names of spreadsheet cells, such as A1, or column letters, such as A. If you enter a name that could conflict into a spreadsheet formula, Lists & Spreadsheet asks for clarification.



You can use several methods to prevent conflicts in your spreadsheet formulas:

- Avoid creating variable names that are similar in format to cell and column names (such as A and $A1$). One method is to use variable names that have two or more letters, such as $AC2$.
- When referring to a variable whose name could conflict with the name of a cell (such as $A1$), precede the variable name with an apostrophe ($'A1$).
- When referring to a column (such as A), follow the column letter with a pair of brackets ($A[]$) to prevent a conflict with the single-letter variable name A . To enter the brackets, press ctrl $\left[\right]$ and then press \blacktriangleright .

Examples

To refer to:	Use this syntax:	Remarks
The shared variable <i>AI</i> .	'A1	The apostrophe avoids a possible conflict with spreadsheet cell A1.
The spreadsheet cell at column A, row 1.	A[1]	This syntax always refers to a spreadsheet cell, avoiding a possible conflict with variable <i>AI</i> .
Column A of the current spreadsheet.	A[]	Brackets avoid a possible conflict with variable <i>A</i> .
The shared variable <i>myvar</i> .	myvar	No special syntax needed, because this name does not conflict with a cell or column reference.



Note: In certain examples, Lists & Spreadsheet may not display the **Conflict Detected** dialog box to notify you of a possible variable-name conflict. Also, the dialog box may appear even when you have used the apostrophe or brackets to prevent a conflict.

Working with rows and columns of data

Selecting a row or column


- ▶ Move to the top of the column, and then press ▲.
– or –
Move to the leftmost cell of the row, and then press ◀.

Resizing a row or column

1. Select the row or column that you want to resize.
2. Press  to display the Lists & Spreadsheet menu.
3. Select **Actions > Resize**, and then select an option:
 - For a column, you can maximize, minimize, or resize the width manually.
 - For a row, you can resize the height manually.
4. If you have chosen to resize manually, use ◀ and ▶ to resize the column, or use ▲ and ▼ to resize the row, and then press .

Inserting an empty row or column

1. Select the column or row where you want to insert the new data.

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Insert** menu, select either **Row** or **Column**.
 - If you are inserting a row, the remaining rows shift down to create space for the new row.
 - If you are inserting a column, the remaining columns shift right to create space.







Note: If other cells contain formulas with relative references to a displaced row or column, those references adjust accordingly.

Deleting entire rows or columns

You can delete a row, column, group of rows, or group of columns. When you delete a row or column, the remaining rows or columns move up or left to fill the gap.

1. Select the column or row that you want to delete.

	A	B	C	D
1	111	444	777	
2	222	555	888	
3	333	666	999	
4				
5				








2. If you are deleting more than one row or column, hold down , and press  and  to select additional columns or press  and  to select additional rows.
3. Press .

The selected rows or columns are deleted.

	A	B	C	D
◆				
1	111	777		
2	222	888		
3	333	999		
4				
5				
B1		777		

Note: If other cells contain formulas that refer to the deleted row or column, those cells show an error. Relative references to cells whose positions have changed because of a deletion adjust accordingly.

Copying rows or columns

1. Select the column or row that you want to copy.
2. If you are copying more than one row or column, press , and then press , , , or  to select an additional item.
3. Press  **C** to copy the selected items.
The selected rows or columns are copied to the Clipboard.
4. Move to any cell in the row or column where you want to place the copied items.
5. Press  **V** to paste the selection.
The copied row or column is pasted in place, replacing the previous contents.

Note: If you copy a named column, it is pasted with the name removed to prevent a variable conflict.

Moving a column

1. Select the column that you want to move.

	A	B	C	D
◆				
1	111	444	777	
2	222	555	888	
3	333	666	999	
4				
5				
B		444		

2. Press **(menu)** to display the Lists & Spreadsheet menu.
3. On the **Actions** menu, select **Move Column**. An insertion bar appears.
4. Press **◀** or **▶** to place the insertion bar at the column's new position, and then press **⏏**.

	A	B	C	D
◆				
1	111	777	444	
2	222	888	555	
3	333	999	666	
4				
5				
B		444		

Note: Relative references to any cell whose position is affected by the move adjust accordingly.

Clearing column data


The Clear Data command lets you remove the data from selected columns. Clear Data does not delete the column, and it does not clear a column's list name or column formula.

After clearing the data, Lists & Spreadsheet recalculates column formulas for the selected columns. This makes Clear Data useful for capturing a fresh set of data from another application or selectively generating a fresh column of random numbers.

1. Select the column or columns that you want to clear.

In this example, columns A through E have been selected.

	A list1	B	C listrand	D	E
		=a[]+10	=rand(7)	=seqn(u(n	=capture(ge
1	1	11	0.556442	1.	2.16255
2	2	12	0.260986	2.	2.25913
3	35	45	0.735197	3.	2.26644
4	4	14	0.35119	5.	2.29058
5	5	15	0.729186	8.	2.30742
6			0.403646	13.	2.32425
7			0.540476		2.3557
A:E		list1			

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Data** menu, select **Clear Data**.

A	list1	B	C	listrand	D	E
		=a[]+10	=rand(7)	=seqn(u(n	=capture(gec	
1			0.138306	1.	2.37985	
2			0.153569	2.		
3			0.793137	3.		
4			0.427003	5.		
5			0.593722	8.		
6			0.408677	13.		
7			0.155084			
A1						

Note: If a recalculated formula produces the same data as before, as in column D of this example, it may appear that the Clear Data command has failed.

Sorting data


You can sort a selected area of the spreadsheet in ascending or descending order. You select which column in the selected area will be used as the key for the sort. When the sort moves data up or down in the key column, the corresponding data in the other selected columns is also moved up or down. This preserves the integrity of each row.

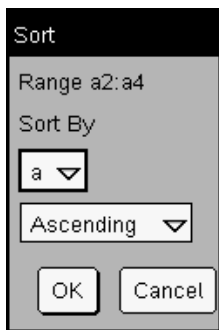
Note: Sorting is based on numeric values. If you select a key column that contains text, you could get unexpected results.

Sorting a range of cells in a column

1. Select the range of cells.

	A	B	C	D
◆				
1		1 sue		345
2		2 bob		299
3		3 lori		601
4		4 burt		445
5		5 jean		563
A2:A4		2		

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Actions** menu, select **Sort**.




4. Select **Descending** as the sort method for this example, and then select **OK**.

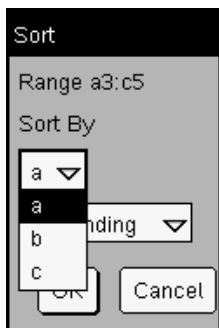
	A	B	C	D	E
◆					
1		1 sue	345		
2		4 bob	299		
3		3 lori	601		
4		2 burt	445		
5		5 jean	563		
A2:A4		4			

Sorting a rectangular region

1. Select the region of cells.

	A	B	C	D	E
◆					
1		1 sue	345		
2		2 bob	299		
3		3 lori	601		
4		4 burt	445		
5		5 jean	563		
A3:C5		3			

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Actions** menu, select **Sort** to display the **Sort** dialog box.
4. Select column **a** as the column on which the sort will be based for this example. You can select from columns within the selected region only.




5. Select **Descending** as the sort method for this example, and then select **OK**.

	A	B	C	D	E
◆					
1		1 sue	345		
2		2 bob	299		
3		5 jean	563		
4		4 burt	445		
5		3 lori	601		
A3:C5		3			

Sorting entire columns

1. Select the range of columns to sort.

	A	B	C	D	E
◆					
1		1 sue	345		
2		2 bob	299		
3		3 lori	601		
4		4 burt	445		
5		5 jean	563		
A:C		3			

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Actions** menu, select **Sort**.
4. Select column **a** as the column on which the sort will be based for this example.
5. Select **Descending** as the sort method for this example, and then select **OK**.

	A	B	C	D	E
◆					
1		5 jean	563		
2		4 burt	445		
3		3 lori	601		
4		2 bob	299		
5		1 sue	345		
A:C		3			

Generating columns of data

You can create a column of values based on another column. You can also create a column based on any of several types of sequential data.

Entering a formula in the header row of the column tells the Lists & Spreadsheet application that you want to apply the formula to all the cells in the column, not just to a single cell.

	A	B	C	D	E
		$=xbar*2$	$=a[]/(2.)$	$=seqn(u(n$	
1	1	25.	0.5	1.	
2	5	25.	2.5	5.	
3	15	25.	7.5	6.	
4	45	25.	22.5	11.	
5	7	25.	3.5	17.	
D	$=seqn(u(n-1)+u(n-2),\{1,5\})$				

- ❶ Column formula based on a variable
- ❷ Column formula based on another column
- ❸ Column formula that generates a sequence

Notes

- If you generate data in a column that already contains one or more cell values, Lists & Spreadsheet asks for confirmation before replacing the existing values. Proceeding removes all of the existing values in the column.
- If you edit a cell manually in a column of generated data, Lists & Spreadsheet asks for confirmation before replacing the generated data. Proceeding removes the generated data for the entire column.

Creating column values based on another column

1. Select the header cell (second cell from the top) of the column where you want to enter a column formula.
2. Type = (press \ominus) followed by the expression, and then press ⏏ . Use brackets ([]) after any column letter you include in the formula. For example, type $=A[]^2$ (press \ominus Ⓐ ⌘ ⌈ ⌋ Ⓐ ⌘ 2) to create a column of values in which each cell is the square of the corresponding cell of column A.

Lists & Spreadsheet shows the formula in the header cell and fills the column with the results.

A	B	C	D
	=a[]^2		
1	12	144	
2	15	225	
3	18	324	
4	20	400	
5	21	441	
B =a[]^2			

Generating a list of random numbers

1. Select the header of the column in which you want to generate the list of random numbers.
2. Press \ominus and then type the expression for generating the random numbers. You can use the catalog to insert an expression instead of typing characters.

`RandInt (1, 6, 20)`

This example places 20 random integers in the column.

3. Generate (Recalculate) a new set of random numbers:
 - Press ctrl R .

Generating a numerical sequence

1. Select any cell in the column in which you want to generate the sequence.
2. Press menu to display the Lists & Spreadsheet menu.
3. On the **Data** menu, select **Generate Sequence**.
Lists & Spreadsheet displays a dialog for defining the sequence.
4. Type the formula that will be applied to the column values to generate the sequence. Type any starting numbers required by the sequence. **u0** is the first number in the sequence, **u1** is the second, and **u2** is the third.

Sequence

Formula: $u(n) = u(n-1) + u(n-2)$

Initial Terms: 1,2

Max No. Terms: 6

Ceiling Value:

OK Cancel

- Type a maximum value for the sequence, if you want to specify a maximum.
- Type a maximum number of values to be generated, if you want to specify a maximum.
- Select **OK**.

Lists & Spreadsheet shows the formula in the header cell and fills the column with the results.

	B	C	D	E
		=seqn(u(n-		
1	111	777	1.	
2	222	888	2.	
3	333	999	3.	
4			5.	
5			8.	
C	=seqn(u(n-1)+u(n-2),{1,2},6)			

Note: If you prefer, you can enter a formula for the sequence directly into the header cell of the column.

For example, enter =seqn(u(n-1)+u(n-2),{2,5},7,100) to generate a Fibonacci series that uses 2 and 5 as the first two numbers. This sequence stops at a maximum value of 100 or a maximum of 7 values, whichever occurs first.

8. Type the formula in the header cell, and then press $\left(\frac{\Sigma}{\text{enter}}\right)$. For example, enter $=\text{seqn}(u(n-1)+u(n-2)\{2,5\})$ to use 2 and 5 as the first two numbers.

	B	C	D	E
◆		=seqn(u(n-		
1	111	777	2.	
2	222	888	5.	
3	333	999	7.	
4			12.	
5			19.	
C1		=(2)·1.		

Creating and sharing spreadsheet data as lists

You can define a column as a named list of elements of the same type of data. After defining a list, you can link to it from Graphs & Geometry, Calculator, Data & Statistics, and other instances of Lists & Spreadsheet within the current problem.

Note: Lists & Spreadsheet can display a maximum of 2500 elements in a list.

Sharing a spreadsheet column as a list variable

You share a column of data by naming it as a list variable.


Note: Avoid defining variables that use the same names as those used for statistical analysis. In some cases, an error condition could occur.

Variable names used for statistical analysis are listed in the *TI-Nspire Reference Guide*, under the **stat.results** entry.

Method 1



1. Press \blacktriangle as necessary to select the name cell (the white cell at the top) of the column that you want to share.

	A	B	C	D
◆				
1	456			
2	445			
3	435			
4	233			
5				
	A			

2. Type a name for the shared list. for example, type `width`.
3. Press .

	A	B	C	D
◆	<code>width</code>			
1	456			
2	445			
3	435			
4	233			
5				
	A	<code>width</code>		

Method 2

1. Press  as necessary to select the header cell (the second cell from the top) of the column that you want to share.
2. Press , and select **Store Var**.


An expression is inserted into the formula cell with `var` as a placeholder for the list name.

	A	B	C	D
◆	<code>var:=</code>			
1		6		
2		5		
3		4		
4		3		
5		2		
A	<code>var:=</code>			

- Replace the letters "var" with a name for the shared list. For example, type `width`.

The header cell now contains an expression similar to `width:=`.

	A	B	C	D
◆	<code>width:=</code>			
1		6		
2		5		
3		4		
4		3		
5		2		
A	<code>width:=</code>			

- Add the formula at the end of the expression. For example, `width:=E[]*3`.
- Press .

The column is now available as a list variable to other TI-Nspire™ applications.

Notes:

- If a variable with the name you specified already exists in the current problem, Lists & Spreadsheet displays an error message.


- Because a list cannot contain empty elements, any empty cells are automatically given a value of zero.

You can refer to a specific element in a named list from the Calculator application. Use the list name and the element's position within the list. In a list named Heights, for example, refer to the first element as Heights[1]. The expression Heights[2] refers to the second element, and so on.

Linking to an existing list variable

Linking a Lists & Spreadsheet column to an existing list variable lets you easily view and edit the values in the list. The list can be any shared list in the current problem and can be defined in Graphs & Geometry, Calculator, or any instance of Lists & Spreadsheet.

After you link a column to a list, Lists & Spreadsheet automatically shows any changes that you make to the list with other TI-Nspire™ CAS applications.

1. Press \blacktriangle as necessary to select the header cell (the second cell from the top) of the column that you want to link to the variable.
2. Press , and select **Store Var**.
3. Type = followed by an apostrophe and the name of the list.
For example, type = 'width.

Note: Use caution if you link to a system variable. Doing so could prevent the variable from being updated by the system. System variables include *ans* and statistics results (such as *stat.results*, *stat.RegEqn*, and *stat.Resid*).


4. Press .

The column shows the list elements.

Inserting an element in a list

When you insert an element in a list, the remaining elements shift downward to create space. For example, if you insert an element at position L1[2], the element that was previously L1[2] shifts down to become L1[3], and so on to the end of the list.



The downward shift affects only the column defined as a list. No other columns are affected.


1. Press  to display the Lists & Spreadsheet menu.
2. On the **Insert** menu, select **Insert Cell**.

Deleting an element from a list

When you delete an element, the remaining list elements shift upward to close the gap. For Example, if you delete element L1[3], the element that was previously L1[4] shifts up to become L1[3], and so forth to the end of the list.

The upward shift affects only the selected column.

1. Select the cell that you want to delete.
2. Display the context menu for the cell:
 - Press  .
3. Select **Delete Cell**.

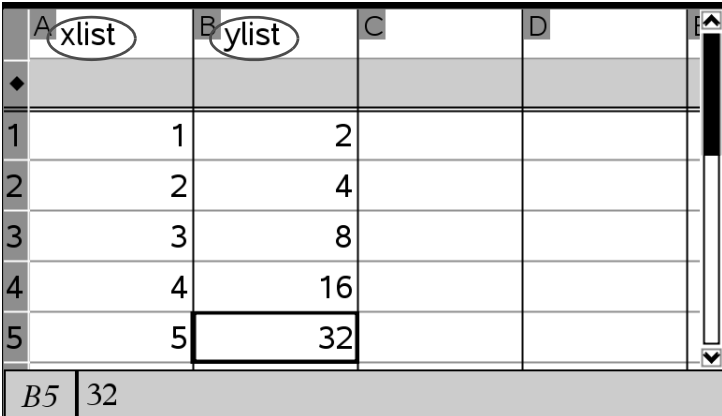
Note: If you press  to clear the contents of the cell instead of deleting the list element, the element is assigned a value of 0 (zero). The remaining list elements do not shift.

Graphing spreadsheet data

You can easily create a dot plot of the data in one column or a scatter plot of two adjacent columns by using the Quick Graph feature. This feature displays the graphed data using the Data & Statistics application.

To create a scatter plot:


1. Name both of the two columns to declare them as lists.



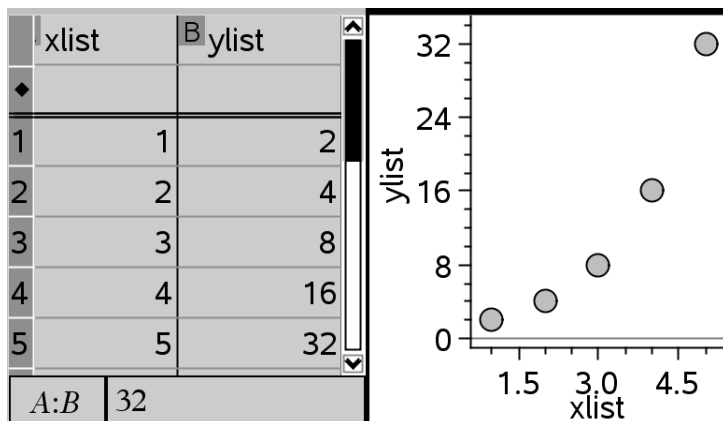
	A xlist	B ylist	C	D
◆				
1		1	2	
2		2	4	
3		3	8	
4		4	16	
5		5	32	
	B5	32		

2. Select both columns.

	A xlist	B ylist	C	D
◆				
1	1	2		
2	2	4		
3	3	8		
4	4	16		
5	5	32		
A:B		32		

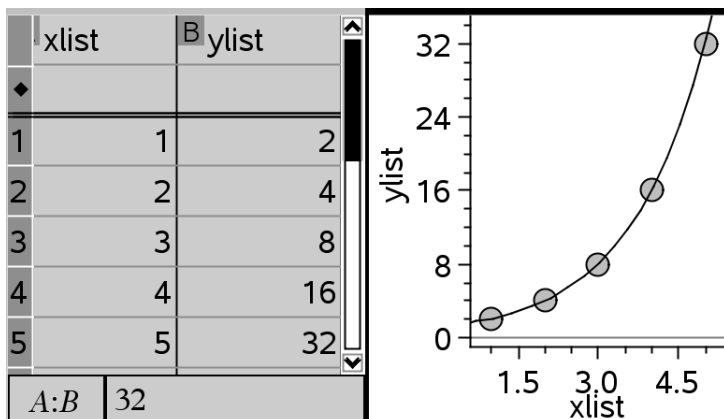
- Press  to display the Lists & Spreadsheet menu.
- On the **Data** menu, select **Quick Graph**.

A Data & Statistics work space is added to the page and shows the plotted data. The leftmost of the two lists is plotted on the x axis, and the other list is plotted on the y axis.



- (Optional) Use the Data & Statistics features to analyze or visually enhance the graph.

Note: Refer to Using Data and Statistics for information about analyzing and exploring graphs.

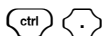


Capturing data from Graphs & Geometry

You can use Lists & Spreadsheet to capture information about objects from Graphs & Geometry. For example, you might want to track changes in the area of a triangle as you change the length of a side.

You can select manual or automatic capture:

- With manual capture, you trigger the capture of each data element by pressing the following key combination.



- With automatic capture, the capture of each data value is triggered automatically when you move or animate the target in Graphs & Geometry.

Capturing data manually

1. Select any cell in the column in which you want to capture the values.

Note: Captured values will replace values in the column.

2. Press **menu** to display the Lists & Spreadsheet menu.
3. On the **Data** menu, select **Data Capture**, and then select **Manual Data Capture**.

A capture expression is inserted into the header cell with *var* as a placeholder for the name of the variable you are capturing.




	A	B	C	D
◆	$=capture(var,0)$			
1				
2				
3				
4				
5				
A	$=capture(var,0)$			

4. Replace the letters “var” with the name of the variable to capture from Graphs & Geometry. For example, type `area`.

The header cell now contains an expression similar to `=capture(area,0)`.

	A	B	C	D
◆	$=capture(area,0)$			
1				
2				
3				
4				
5				
A	$=capture(area,0)$			

Note: The argument “0” tells Lists & Spreadsheet that you want to trigger each capture manually.


- Press .
- Using Graphs & Geometry, change the object whose attribute (*area* in this example) you are capturing.
- Each time you are ready to capture the current value of *area*:
 - Press  .

The current *area* value is added to the end of the list as a list element.

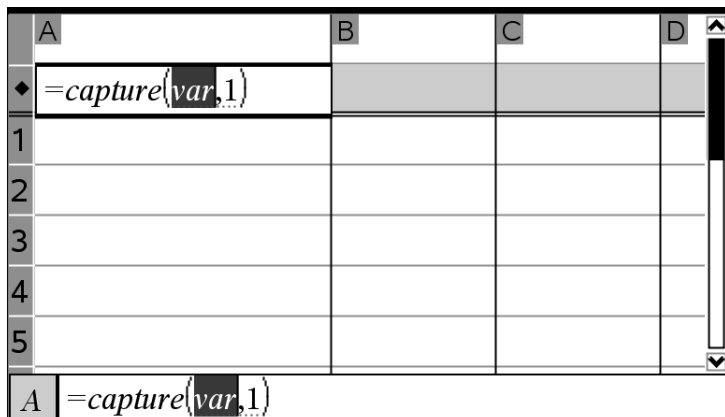
Capturing data automatically

1. Select any cell in the column in which you want to capture the values.

Note: Captured values will replace values in the column.

2. Press  to display the Lists & Spreadsheet menu.
3. On the **Data** menu, select **Data Capture**, and then select **Automated Data Capture**.

A capture expression is inserted into the header cell with *var* as a placeholder for the name of the variable you are capturing.



A	B	C	D
◆ =capture(var,1)			
1			
2			
3			
4			
5			


A =capture(var,1)

4. Replace the letters "*var*" with the name of the variable to capture. For example, type `objpathX`. Alternatively, you can select the variable name from the Variables menu.

The header cell now contains an expression similar to
`=capture('objpathX',1)`.

A	B	C	D
◆ =capture(objpathX,1)			
1			
2			
3			
4			
5			
A	=capture(objpathX,1)		

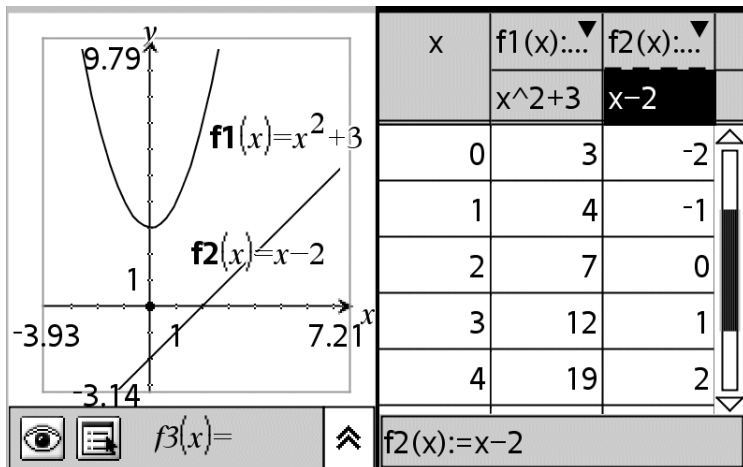
Note: The argument "1" tells Lists & Spreadsheet that you want the captures to be triggered by the variable change.

5. Press .
6. When you are ready to begin capturing the values of *objpathX*, begin moving the object or start the animation that affects it in Graphs & Geometry.

Each captured value is added to the end of the list in Lists & Spreadsheet as a list element.

Creating function tables

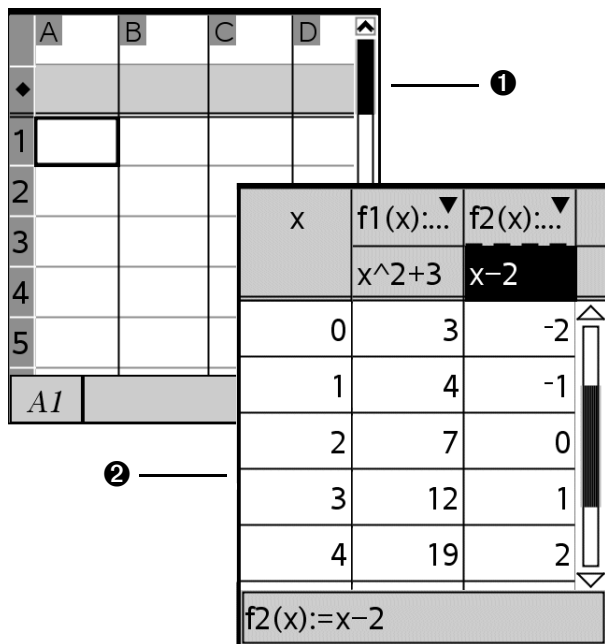
The Lists & Spreadsheet application lets you create a table of function values for any defined function in the current problem. You can set the parameters for the table and even edit a function definition without leaving Lists & Spreadsheet.



Showing and Hiding function tables

Anytime Lists & Spreadsheet is the active application, you can alternate between the standard Lists & Spreadsheet view and the function table view.

- Press ctrl T to toggle the view.

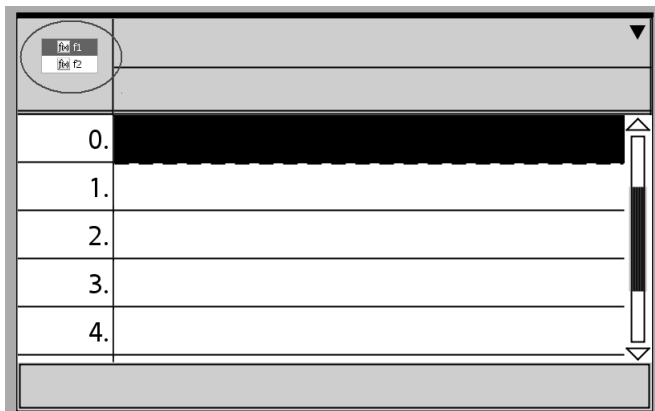


- ❶ Lists & Spreadsheet view
- ❷ Function table view

Generating a function table

1. Make sure you have defined at least one function in Graphs & Geometry, Calculator, or Data & Statistics. Refer to Using Graphs & Geometry for more information.
2. Toggle to the function table view:
 - In Lists & Spreadsheet, press ctrl T .

The function table view appears with a small box listing available functions.



Note: If a previous function is displayed, press \blacktriangleright to move to an empty column.

3. Select the function for which you want to create a table.


By default, the table is generated using a start value of 0, a step value of 1, and the automatic setting for the independent and dependent variables.

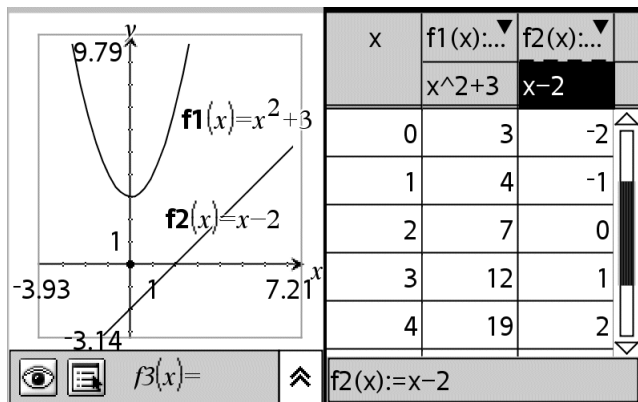
x	f1(x):...	
	x^2+3	
0.	3.	
1.	4.	
2.	7.	
3.	12.	
4.	19.	
3.		

Adding a function table from Graphs & Geometry

Adding a function table from Graphs & Geometry automatically creates an instance of Lists & Spreadsheet if none already exists on the current page. It also shows the function table view and automatically generates a table for the active Graphs & Geometry functions.

1. In Graphs & Geometry, select the functions for which you want to create a table.

- Press  to display the Graphs & Geometry menu.
- On the **View** menu, select **Add Function Table**.



Viewing values in a function table

- Press \blacktriangle or \blacktriangledown to view the values in the table.

As you move through the table, Lists & Spreadsheet generates the function values based on the independent variable (shown in the leftmost column). Scrolling upward from 0 displays negative values of the independent variable.

x	f2(x):...	f1(x):...
	$x-2$	x^2+3
-3.	-5.	12.
-2.	-4.	7.
-1.	-3.	4.
0.	-2.	3.
1.	-1.	4.
-3.		

Editing a function

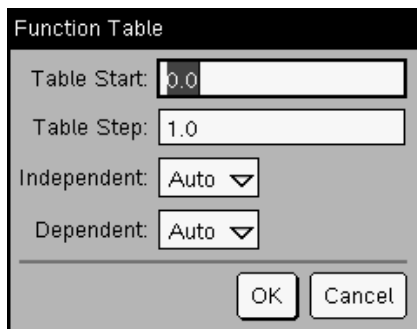
Besides using the other applications, such as Calculator and Graphs & Geometry, you can edit a function definition in the function table. Changes that you make are reflected in the other applications automatically.

1. Press **tab** as necessary to highlight the top area of the function tables, press **enter**, use **left**, **right**, **up**, and **down** to highlight the function's expression, and then press **enter**.
2. A cursor appears in the expression.
3. Edit the expression, and then press **enter**.
4. The table for the function is updated, and the Graphs & Geometry graph of the function is also updated.

Changing the settings for a function table

Each function table uses initial settings that make it easy to scroll through values. If you prefer, you can set the Table Start and Table Step values manually, and you can choose to enter values manually for the independent and/or dependent variable.






1. Press **menu** to display the Graphs & Geometry menu.
2. On the **Function Table** menu, select **Edit Function Table Settings**.



3. Press **tab** to move among the settings, and either type a value or press **up** or **down** to change a setting.

If you select **Ask** instead of **Auto** for a variable, you can enter a value manually when you select a cell. **Auto** populates the table starting at table start and displays an independent and dependent value for each step.

Deleting a column in the function table

1. Press  as necessary to highlight the top area of the function tables, press , use  and  to highlight the top cell of the column.
2. Press .

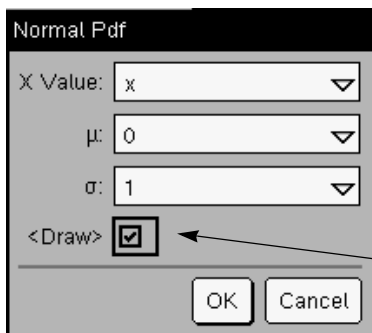
Using table data for statistical analysis

Lists & Spreadsheet uses wizards to help you perform statistical analyses on data in table columns. You specify the location of the data, and Lists & Spreadsheet stores the results in two columns: one for the result names, and one for the corresponding values.

Plotting statistical data

Some of the statistics wizards display a **Draw** check box. By default, the box is not checked. Checking the box creates a Data & Statistics work area on the page and plots the results in that work area.

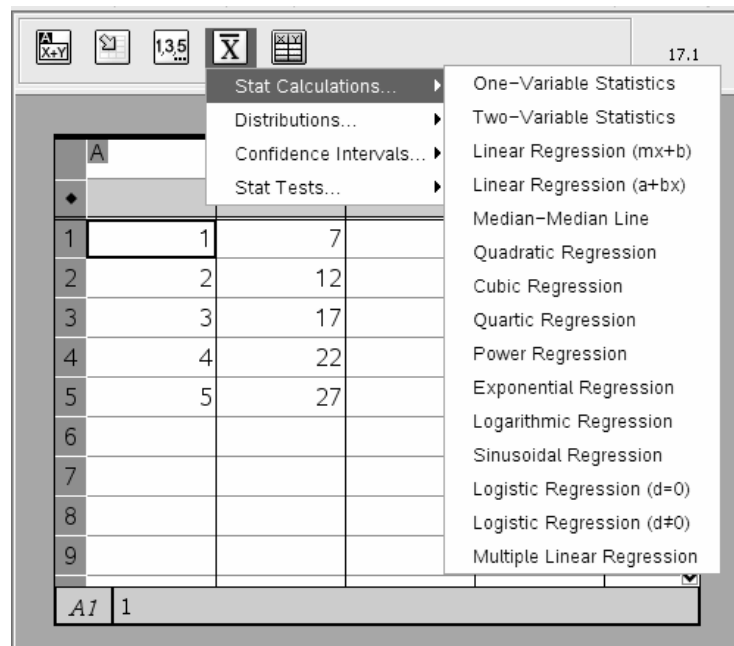
Note: The check box is displayed only if you select a header cell (second cell from the top) before beginning the analysis.



The image shows a dialog box titled "Normal Pdf". It contains three input fields: "X Value:" with a dropdown menu showing "x", " μ :" with a dropdown menu showing "0", and " σ :" with a dropdown menu showing "1". Below these fields is a check box labeled "<Draw>" which is checked. At the bottom of the dialog are "OK" and "Cancel" buttons. An arrow points from the text "Draw check box in the Normal PDF wizard." to the checked box.

Draw check box in the Normal PDF wizard.

Statistical calculations



The screenshot shows a spreadsheet window with a menu open. The menu is titled 'Stat Calculations...' and lists the following options:

- One-Variable Statistics
- Two-Variable Statistics
- Linear Regression (mx+b)
- Linear Regression (a+bx)
- Median-Median Line
- Quadratic Regression
- Cubic Regression
- Quartic Regression
- Power Regression
- Exponential Regression
- Logarithmic Regression
- Sinusoidal Regression
- Logistic Regression (d=0)
- Logistic Regression (d≠0)
- Multiple Linear Regression

The spreadsheet data is as follows:

	A		
1	1		7
2	2		12
3	3		17
4	4		22
5	5		27
6			
7			
8			
9			

The status bar at the bottom shows 'A1 1'.

Performing a statistical calculation

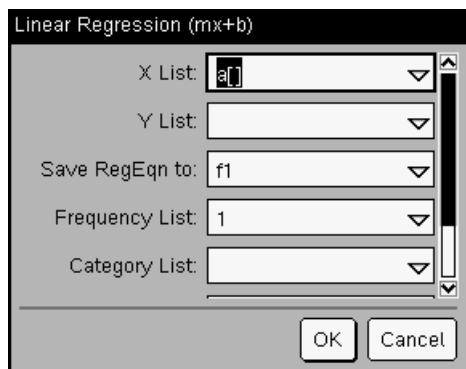
Suppose you want to fit a $y=mx+b$ linear regression model to the following two lists:

	A	B	C	D
1	1		7	
2	2		12	
3	3		17	
4	4		22	
5	5		27	

The status bar at the bottom shows 'A1 1'.

1. Select the header/formula cell (second cell from the top) in column A.
2. Press **(menu)** to display the Lists & Spreadsheet menu.
3. On the **Statistics** menu, select **Stat Calculation**, and select **Linear Regression (mx+b)** to choose the regression model.

A wizard opens, giving you a labeled box to type each argument. Because you selected a cell in advance, the column for **X List** is already filled in.



4. Press **(tab)** to move to the **Y List** box, or click the drop-down arrow to select a named list.
5. Type **b []** to specify the values in column B as **Y List**.
6. If you want to store the regression equation in a specified variable, press **(tab)**, and then replace **Save RegEqn To** with the name of the variable.
7. Press **(tab)** as necessary to move to the **1st Result** box.
8. Type **c []** as the column letter for the first result column.

Linear Regression (mx+b)

Save RegEqn to: f1

Frequency List: 1

Category List:

Include Categories:

1st Result Column: c[]

OK Cancel

9. Select **OK**.

Lists & Spreadsheet inserts two columns: one containing the names of the results, and one containing the corresponding values.

A	B	C	D	E
			=LinRegMx(a[],b[],1): CopyVar S	
1	1	7	Title	Linear Regression (mx+b)
2	2	12	RegEqn	m*x+b
3	3	17	m	5.
4	4	22	b	2.
5	5	27	r ²	1.
6			r	1.
7			Resid	{0.,0.,0.,0.,0.}
D	=LinRegMx(a[[]],b[[]],1): CopyVar Stat.RegEqn,'f1: Copy'			

Note: The results are linked to the source data. For example, you can change a value in column A, and the regression equation is updated automatically.

When a system variable is used for statistical results, Lists & Spreadsheet uses a standard statistical variable name that it automatically increments for each calculation. You can access statistical analysis results stored in variables from other TI-Nspire™ applications by using the **Var** menu.

Lists & Spreadsheet stores statistical results using a variable-group name with the format `stat.nnn`, where *nnn* is the result name (for example, `stat.RegEqn` and `stat.Resid`). The use of standard names for variables makes it easier to identify and use the statistical variables later. You can edit the formula in the header cell if you want to use a custom variable group instead of the standard name.

You could use the following formula to store the results in the variable group **MystatsB**.

```
=LinRegMx(a[],b[],1):CopyVar Stat.,MystatsB.
```

Later, you could view the results by entering the following expression in the Calculator application or in another column of the Lists & Spreadsheet application:

```
MystatsB.results
```

Note: If you specify a custom variable name, be sure to make a note of it. This prevents unexpected operation when you need to refer to the name later.

Supported Statistical Calculations

The **Stat Calculations** menu lets you select from the calculations described below. For a complete description of inputs and outputs, refer to the *TI-Nspire Reference Guide* details for the function name that is in parentheses.

One-Variable Statistics (OneVar)

The *One-Variable Statistics* calculation analyzes data with one measured variable. The statistical data returned for a data set using this analysis technique are:

- sample mean, \bar{x}
- sum of the data, Σx
- sum of the squared data, Σx^2
- sample standard deviation, s_x
- population standard deviation, σ_x
- sample size, n
- X-min
- first quartile, Q_1
- median

- third quartile, Q_3
- X-max
- sum of squared deviations, $SSx = \sum(x - \bar{x})^2$

Each element in *freqlist* is the frequency of occurrence for each corresponding data point in *Xlistname*. *freqlist* elements must be integers > 0.

Two-Variable Statistics (TwoVar)

The *Two-Variable Statistics* calculation analyzes paired data. *List 1* is the independent variable. *List 2* is the dependent variable. The statistical data returned for the data sets using this analysis technique are:

For each list:

- sample mean, \bar{x} or \bar{y}
- sum of the data, Σx or Σy
- sum of the squared data, Σx^2 or Σy^2
- sample standard deviation, $s_x = s_{n-1}x$ or $s_y = s_{n-1}y$
- population standard deviation, $\sigma_x = \sigma_n x$ or $\sigma_y = \sigma_n y$
- X-min or Y-min
- first quartile, Q_1X or Q_1Y
- median
- third quartile, Q_3X or Q_3Y
- X-max or Y-max
- sum of squared deviations, $SSx = \sum(x - \bar{x})^2$ or $SSy = \sum(y - \bar{y})^2$

Additional data:

- sample size for each data set, n
- Σxy
- correlation coefficient, r

Each element in *freqlist* is the frequency of occurrence for each data pair (*List1*,*List2*).

Linear Regression (mx+b) (LinRegMx)

The **Linear Regression (mx+b)** fits the model equation $y=ax+b$ to the data using a least-squares fit. It displays values for **m** (slope) and **b** (y-intercept).

Linear Regression (a+bx) (LinRegBx)

The **Linear Regression (a+bx)** fits the model equation $y=a+bx$ to the data using a least-squares fit. It displays values for **a** (y-intercept), **b** (slope), r^2 , and **r**.

Median-Median Line Regression (MedMed)

The **Median-Median Line** regression fits the model equation $y=ax+b$ to the data using the median-median line (resistant line) technique, calculating the summary points $x_1, y_1, x_2, y_2, x_3,$ and y_3 . **Median-Median Line** displays values for **a** (slope) and **b** (y-intercept).

Quadratic Regression (QuadReg)

The **QuadReg** (quadratic regression) fits the second-degree polynomial $y=ax^2+bx+c$ to the data. It displays values for **a, b, c,** and R^2 . For three data points, the equation is a polynomial fit; for four or more, it is a polynomial regression. At least three data points are required.

Cubic Regression (CubicReg)

The **CubicRegression** fits the third-degree polynomial $y=ax^3+bx^2+cx+d$ to the data. It displays values for **a, b, c, d,** and R^2 . For four points, the equation is a polynomial fit; for five or more, it is a polynomial regression. At least four points are required.

Quartic Regression (QuartReg)

The **Quartic Regression** fits the fourth-degree polynomial $y=ax^4+bx^3+cx^2+dx+e$ to the data. It displays values for **a, b, c, d, e,** and R^2 . For five points, the equation is a polynomial fit; for six or more, it is a polynomial regression. At least five points are required.

Power Regression (PwrReg)

The **Power Regression** fits the model equation $y=ax^b$ to the data using a least-squares fit and transformed values $\ln(x)$ and $\ln(y)$. It displays values for **a, b, $r^2,$** and **r**.

Exponential Regression (ExpReg)

The **Exponential Regression** fits the model equation $y=ab^x$ to the data using a least-squares fit and transformed values x and $\ln(y)$. It displays values for **a, b, $r^2,$** and **r**.

Logarithmic Regression (LogReg)

The **Logarithmic Regression** fits the model equation $y=a+b \ln(x)$ to the data using a least-squares fit and transformed values $\ln(x)$ and y . It displays values for **a, b, $r^2,$** and **r**.

Sinusoidal Regression (SinReg)

The **Sinusoidal Regression** fits the model equation $y=a \sin(bx+c)+d$ to the data using an iterative least-squares fit. It displays values for **a**, **b**, **c**, and **d**. At least four data points are required. At least two data points per cycle are required in order to avoid aliased frequency estimates.

Note: The output of **SinReg** is always in radians, regardless of the Radian/Degree mode setting.

Logistic Regression (d=0) (Logistic)

The **Logistic Regression (d=0)** fits the model equation $y=c/(1+a*e^{-bx})$ to the data using an iterative least-squares fit. It displays values for **a**, **b**, and **c**.

Logistic Regression (d≠0) (LogisticD)

The **Logistic (d≠0)** regression fits the model equation $y=c/(1+a*e^{-bx})+d$ to the data using an iterative least-squares fit. It displays values for **a**, **b**, **c** and **d**.

Multiple Linear Regression (MultReg)

The **Multiple Linear Regression** calculates multiple linear regression of list Y on lists X1, X2, ..., X10.

Note: There is no draw option for multiple linear regression.

Distributions

The screenshot shows a spreadsheet application window with a toolbar at the top. The toolbar includes icons for formulas, undo, a numeric keypad (showing '1,35...'), a mean function icon (\bar{X}), and a data table icon. The spreadsheet grid is visible with columns A through I and rows 1 through 14. The cell A1 contains the text 'A1'. A menu is open, showing the following options:

- Stat Calculations...
- Distributions...**
- Confidence Intervals...
- Stat Tests...

The 'Distributions...' menu is expanded, listing the following statistical functions:

- Normal Pdf
- Normal Cdf
- Inverse Normal
- t Pdf
- t Cdf
- Inverse t
- χ^2 Pdf
- χ^2 Cdf
- Inverse χ^2
- F Pdf
- F Cdf
- Inverse F
- Binomial Pdf
- Binomial Cdf
- Geometric Pdf
- Geometric Cdf
- Poisson Pdf
- Poisson Cdf

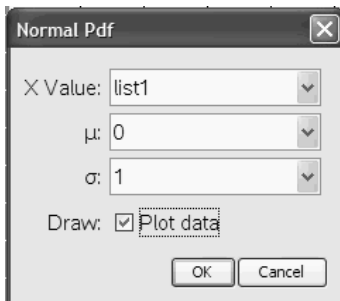
Calculating distributions

Suppose you want to fit the Normal Pdf distribution model to the following two lists:

	A list1	B list2	C	D
◆				
1	5	3		
2	6	4		
3	2	5		
4	4	1		
5	5	3		
6	2	5		
7	1	2		
8				
AI	5			

1. Select the header/formula cell (second cell from the top) in column A.
2. On the **Statistics menu**, select **Distributions**, and select **Normal Pdf** to choose the Distribution model.

A wizard opens, giving you a labeled box to type each argument. You can type values, or select them from the drop down selection list.



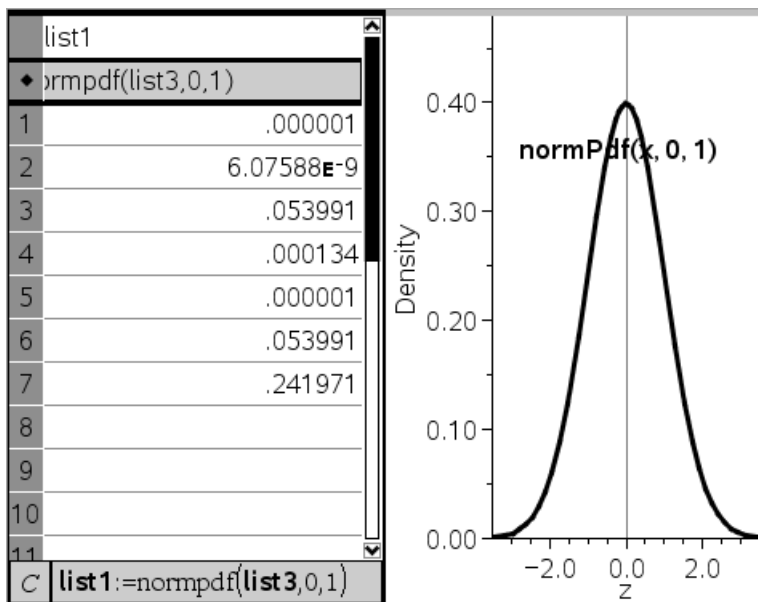
3. Press **tab** as necessary to complete each argument.

- Click the **Draw** check box to see the distribution plotted in Data & Statistics.

Note: The Draw option is not available for all distributions.

- Select **OK**.

Lists & Spreadsheet inserts two columns: one containing the names of the results, and one containing the corresponding values. The results are plotted in Data & Statistics.



Note: The results are linked to the source data. For example, you can change a value in Column A, and the equation updates automatically.

Supported Distribution functions

You can include distribution functions in cells using the same method for entering characters, or include a distribution in a formula cell. When you specify a distribution function in a formula cell, you are required to specify a list (column) that contains the x-values. For each x-value in the list, the distribution returns a corresponding result.

Note: For distribution functions that support the draw option (**normPDF**, **t PDF**, **χ^2 Pdf**, and **F Pdf**), the option is available only if you enter the distribution function in a formula cell.

The following distributions are available from the Lists & Spreadsheet application. For complete information regarding these functions, refer to the *Tl-Nspire Reference Guide* details for the function name that is in parentheses.

Normal Pdf (normPdf)

Normal Pdf computes the probability density function (**pdf**) for the normal distribution at a specified x value. The defaults are mean $\mu=0$ and standard deviation $\sigma=1$. The probability density function (pdf) is:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}, \sigma > 0$$

This distribution is used to determine the probability of the occurrence of a certain value in a normal distribution. The draw option is available when Normal PDF is invoked from a formula cell.

When you access distributions from the formula cell, you must select a valid list from the pull-down to avoid unexpected results. If accessed from a formula cell, you must specify a number for the x -value. The distribution returns the probability that the value you specify will occur.

Normal Cdf (normCdf)

Normal Cdf computes the normal distribution probability between *lowBound* and *upBound* for the specified mean, μ (default=0) and the standard deviation, σ (default=1).

This distribution is useful in determining the probability of an occurrence of any value between the lower and upper bounds in the normal distribution. It is equivalent to finding the area under the specified normal curve between the bounds.

Inverse Normal (invNorm)

Inverse Normal computes the inverse cumulative normal distribution function for a given *area* under the normal distribution curve specified by mean, μ , and standard deviation, σ .

This distribution is useful in determining the x -value of data in the area from 0 to $x < 1$ when the percentile is known.

t Pdf() (tPdf())

t Pdf computes the probability density function (**pdf**) for the t -distribution at a specified x value. *df* (degrees of freedom) must be > 0 . The probability density function (**pdf**) is:

$$f(x) = \frac{\Gamma[(df+1)/2]}{\Gamma(df/2)} \frac{(1+x^2/df)^{-(df+1)/2}}{\sqrt{\pi df}}$$

This distribution is useful in determining the probability of the occurrence of a value when the population standard deviation is not known and the sample size is small. The draw option is available when **t Pdf** is invoked from a formula cell.

t Cdf (tCdf())

t Cdf computes the Student-t distribution probability between *lowBound* and *upBound* for the specified *df* (degrees of freedom).

This distribution is useful in determining the probability of the occurrence of a value within an interval defined by the lower and upper bound for a normally distributed population when the population standard deviation is not known.

Inverse t (invt())

Inverse t computes the inverse cumulative t-distribution probability function specified by Degrees of Freedom, *df*, for a given area under the curve.

This distribution is useful in determining the probability of an occurrence of data in the area from 0 to $x < 1$. This function is used when the population mean and/or population standard deviation is not known.

χ^2 Pdf

χ^2 Pdf computes the probability density function (**pdf**) for the χ^2 (chi-square) distribution at a specified *x* value. *df* (degrees of freedom) must be an integer > 0 . The probability density function (**pdf**) is:

$$f(x) = \frac{1}{\Gamma(df/2)} (1/2)^{df/2} x^{df/2-1} e^{-x/2}, x \geq 0$$

This distribution is useful in determining the probability of the occurrence of a given value from a population with a χ^2 distribution. The draw option is available when χ^2 Pdf is invoked from a formula cell.

χ^2 Cdf

χ^2 Cdf computes the χ^2 (chi-square) distribution probability between *lowBound* and *upBound* for the specified *df* (degrees of freedom).

This distribution is useful in determining the probability of the occurrence of value within given boundaries of a population with a χ^2 distribution.

F Pdf

F Pdf computes the probability density function (**pdf**) for the **F** distribution at a specified x value. *numerator df* (degrees of freedom) and *denominator df* must be integers > 0. The probability density function (**pdf**) is:

$$f(x) = \frac{\Gamma[(n+d)/2]}{\Gamma(n/2)\Gamma(d/2)} \left(\frac{n}{d}\right)^{n/2} x^{n/2-1} (1+nx/d)^{-(n+d)/2}, x \geq 0$$

where n = numerator degrees of freedom
 d = denominator degrees of freedom

This distribution is useful in determining the probability that two samples have the same variance. **F Pdf** The draw option is available when **F Pdf** is invoked from a formula cell.

F Cdf

F Cdf computes the **F** distribution probability between *lowBound* and *upBound* for the specified *dfnumerator* (degrees of freedom) and *dfDenom*.

This distribution is useful in determining the probability that a single observation falls within the range between the lower bound and upper bound.

Binomial Pdf (binomPdf())

Binomial Pdf computes a probability at x for the discrete binomial distribution with the specified *numtrials* and probability of success (p) on each trial. x can be an integer or a list of integers. $0 \leq p \leq 1$ must be true. *numtrials* must be an integer > 0. If you do not specify x , a list of probabilities from 0 to *numtrials* is returned. The probability density function (**pdf**) is:

$$f(x) = \binom{n}{x} p^x (1-p)^{n-x}, x = 0, 1, \dots, n$$

where n = *numtrials*

This distribution is useful in determining the probability of success in a success/failure trial, at trial n . For example, you could use this distribution to predict the probability of getting heads in a coin toss on the 5th toss.

Binomial Cdf (binomCdf())

Binomial Cdf computes a cumulative probability for the discrete binomial distribution with n number of trials and probability p of success on each trial.

This distribution is useful in determining the probability of a success on one trial before all trials are completed. For example, if heads is a successful coin toss and you plan to toss the coin 10 times, this distribution would predict the chance of obtaining heads at least once in the 10 tosses.

Poisson Pdf (poissPdf())

Poisson Pdf computes a probability at x for the discrete Poisson distribution with the specified mean, μ , which must be a real number > 0 . x can be an integer or a list of integers. The probability density function (**pdf**) is:

$$f(x) = e^{-\mu} \mu^x / x!, x = 0, 1, 2, \dots$$

This distribution is useful in determining the probability of obtaining a certain number of successes before a trial begins. For example, you could use this calculation to predict the number of heads that would occur in eight tosses of a coin.

poissoncdf (poissCdf())

poissoncdf computes a cumulative probability for the discrete Poisson distribution with specified mean, λ .

This distribution is useful in determining the probability that a certain number of successes occur between the upper and lower bounds of a trial. For example, you could use this calculation to predict the number of heads displayed between coin toss #3 and toss #8.

geompdf (geomPdf())

geompdf (computes a probability at x , the number of the trial on which the first success occurs, for the discrete geometric distribution with the specified probability of success p . $0 \leq p \leq 1$ must be true. x can be an integer or a list of integers. The probability density function (**pdf**) is:

$$f(x) = p(1-p)^{x-1}, x = 1, 2, \dots$$

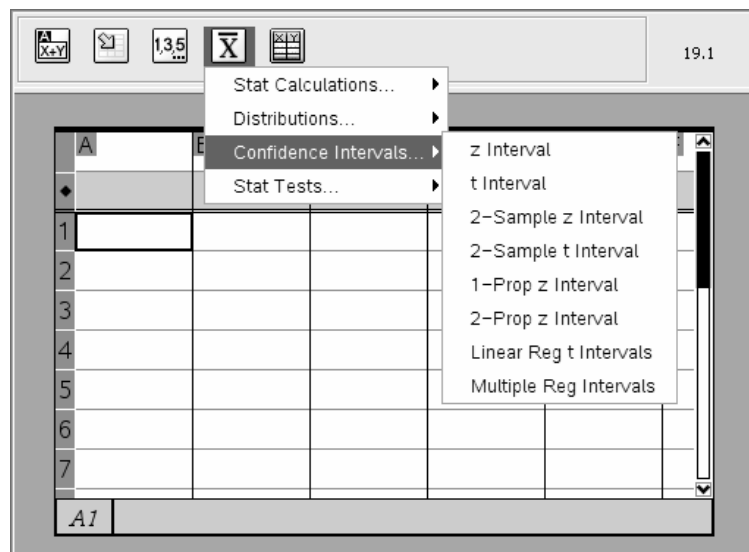
This distribution is useful in determining the likeliest number of trials before a success is obtained. For example, you could use this calculation to predict the number of coin tosses that would be made before a heads resulted.

geomtcdf (geomCdf())

geomtcdf computes a cumulative geometric probability from lowBound to upBound with the specified probability of success, p .

This distribution is useful in determining the probability associated with the first success occurring during trials 1 through n . For example, you could use this calculation to determine the probability that heads display on toss #1, #2, #3, ..., # n .

Confidence Intervals



Supported Confidence Intervals

The following confidence intervals are available from the Lists & Spreadsheets application. For complete information regarding these functions, refer to the *TI-Nspire Reference Guide* details for the function name that is in parentheses.

***z* Interval (*zInterval*)**

***z* Interval** (one-sample *z* confidence interval) computes a confidence interval for an unknown population mean, μ , when the population standard deviation, σ , is known. The computed confidence interval depends on the user-specified confidence level.

This test is useful in determining how far from a population mean a sample mean can get before indicating a significant deviation.

***t* Interval (*tInterval*)**

***t* Interval** (one-sample *t* confidence interval) computes a confidence interval for an unknown population mean, μ , when the population standard deviation, σ , is unknown. The computed confidence interval depends on the user-specified confidence level.

This test is useful in examining whether the confidence interval associated with a confidence level contains the value assumed in the hypothesis. Like the z Interval, this test helps you determine how far from a population mean a sample mean can get before indicating a significant deviation when the population mean is unknown.

2-Sample z Interval (zInterval_2Samp)

2-Sample z Interval (two-sample z confidence interval) computes a confidence interval for the difference between two population means ($\mu_1 - \mu_2$) when both population standard deviations (σ_1 and σ_2) are known. The computed confidence interval depends on the user-specified confidence level.

This test is useful in determining if there is statistical significance between the means of two samples from the same population. For example, this test could determine whether there is significance between the mean SAT score of female students and the mean of SAT score of male students at the same school.

2-Sample t Interval (tInterval_2Samp)

2-Sample t Interval (two-sample t confidence interval) computes a confidence interval for the difference between two population means ($\mu_1 - \mu_2$) when both population standard deviations (σ_1 and σ_2) are unknown. The computed confidence interval depends on the user-specified confidence level.

This test useful in determining if there is statistical significance between the means of two samples from the same population. It is used instead of the 2-sample z confidence interval in situations where the population is too large to measure in order to determine the standard deviation.

1-Prop z Interval (zInterval_1Prop)

1-Prop z Interval (one-proportion z confidence interval) computes a confidence interval for an unknown proportion of successes. It takes as input the count of successes in the sample x and the count of observations in the sample n . The computed confidence interval depends on the user-specified confidence level.

This test is useful in determining the probability of a given number of successes that can be expected for a given number of trials. For instance, casino examiners would use this test to determine if observed payouts for one slot machine demonstrate a consistent pay out rate.

2-Prop z Interval (zInterval_2Prop)

2-Prop z Interval (two-proportion z confidence interval) computes a confidence interval for the difference between the proportion of successes in two populations (p_1-p_2). It takes as input the count of successes in each sample (x_1 and x_2) and the count of observations in each sample (n_1 and n_2). The computed confidence interval depends on the user-specified confidence level.

This test is useful in determining if two rates of success differ because of something other than sampling error and standard deviation. For example, a bettor could use this test to determine if there is an advantage in the long run by playing one game or machine versus playing another game or machine.

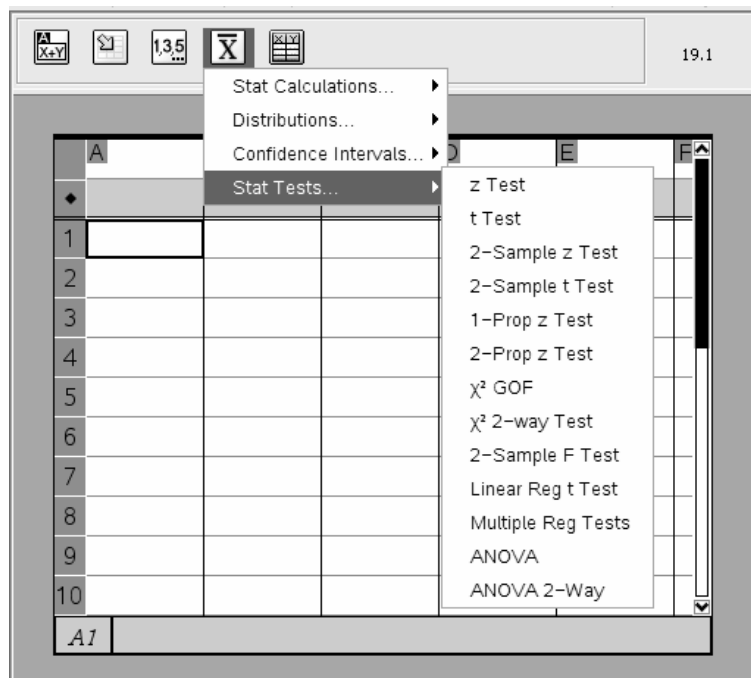
Linear Reg t Intervals (LinRegtIntervals)

Linear Reg t Intervals computes a linear regression t confidence interval for the slope coefficient b . If the confidence interval contains 0, this is insufficient evidence to indicate that the data exhibits a linear relationship.

Multiple Reg Intervals (MultRegIntervals)

Computes multiple regression prediction confidence interval for the calculated y and a confidence for y .

Stat tests



Supported Statistical tests

The following hypothesis tests are available from the Lists & Spreadsheets application. For complete information regarding these functions, refer to the *TI-Nspire Reference Guide* details for the function name that is in parentheses.

Some of the wizards for Stat Tests display a **Draw** check box. By default, the box is not checked. Checking the box creates a Data & Statistics work area on the page and plots the results in that work area.

Z-test (zTest)

Z-Test (one-sample z test) performs a hypothesis test for a single unknown population mean, μ , when the population standard deviation, σ , is known. It tests the null hypothesis $H_0: \mu = \mu_0$ against one of the alternatives below.

- $H_a: \mu \neq \mu_0$ ($\mu: \neq \mu_0$)
- $H_a: \mu < \mu_0$ ($\mu: < \mu_0$)

- $H_a: \mu > \mu_0$ ($\mu: > \mu_0$)

This test is used for large populations that are normally distributed. The standard deviation must be known.

This test is useful in determining if the difference between a sample mean and a population mean is statistically significant when you know the true deviation for a population.

t-test (tTest)

t-Test (one-sample *t* test) performs a hypothesis test for a single unknown population mean, μ , when the population standard deviation, σ , is unknown. It tests the null hypothesis $H_0: \mu = \mu_0$ against one of the alternatives below.

- $H_a: \mu \neq \mu_0$ ($\mu: \neq \mu_0$)
- $H_a: \mu < \mu_0$ ($\mu: < \mu_0$)
- $H_a: \mu > \mu_0$ ($\mu: > \mu_0$)

This test is similar to a z-test, but is used when the population is small and normally distributed. This test is used more frequently than is the z-test because small sample populations are more frequently encountered in statistics than are large populations.

This test is useful in determining if two normally distributed populations have equal means, or when you need to determine if a sample mean differs from a population mean significantly and the population standard deviation is unknown.

2-SampZTest (zTest_2Samp)

2-SampZTest (two-sample *z* test) tests the equality of the means of two populations (μ_1 and μ_2) based on independent samples when both population standard deviations (σ_1 and σ_2) are known. The null hypothesis $H_0: \mu_1 = \mu_2$ is tested against one of the alternatives below.

- $H_a: \mu_1 \neq \mu_2$ ($\mu_1: \neq \mu_2$)
- $H_a: \mu_1 < \mu_2$ ($\mu_1: < \mu_2$)
- $H_a: \mu_1 > \mu_2$ ($\mu_1: > \mu_2$)

2-SampTTest (tTest_2Samp)

2-SampTTest (two-sample *t* test) tests the equality of the means of two populations (μ_1 and μ_2) based on independent samples when neither population standard deviation (σ_1 or σ_2) is known. The null hypothesis $H_0: \mu_1 = \mu_2$ is tested against one of the alternatives below.

- $H_a: \mu_1 \neq \mu_2$ ($\mu_1: \neq \mu_2$)
- $H_a: \mu_1 < \mu_2$ ($\mu_1: < \mu_2$)
- $H_a: \mu_1 > \mu_2$ ($\mu_1: > \mu_2$)

1-PropZTest (zTest_1Prop)

1-PropZTest (one-proportion z test) computes a test for an unknown proportion of successes (prop). It takes as input the count of successes in the sample x and the count of observations in the sample n . **1-PropZTest** tests the null hypothesis $H_0: \text{prop} = p_0$ against one of the alternatives below.

- $H_a: \text{prop} \neq p_0$ (**prop: $\neq p_0$**)
- $H_a: \text{prop} < p_0$ (**prop: $< p_0$**)
- $H_a: \text{prop} > p_0$ (**prop: $> p_0$**)

This test is useful in determining if the probability of the success seen in a sample is significantly different from the probability of the population or if it is due to sampling error, deviation, or other factors.

2-PropZTest (zTest_2Prop)

2-PropZTest (two-proportion z test) computes a test to compare the proportion of successes (p_1 and p_2) from two populations. It takes as input the count of successes in each sample (x_1 and x_2) and the count of observations in each sample (n_1 and n_2). **2-PropZTest** tests the null hypothesis $H_0: p_1 = p_2$ (using the pooled sample proportion \hat{p}) against one of the alternatives below.

- $H_a: p_1 \neq p_2$ (**p1: $\neq p_2$**)
- $H_a: p_1 < p_2$ (**p1: $< p_2$**)
- $H_a: p_1 > p_2$ (**p1: $> p_2$**)

This test is useful in determining if the probability of success seen in two samples is equal.

χ^2 GOF-Test

χ^2 GOF-Test (Chi Square Goodness of Fit) performs a test to confirm that sample data is from a population that conforms to a specified distribution. For example, χ^2 GOF can confirm that the sample data came from a normal distribution.

χ^2 -Test

χ^2 -Test (chi-square test) computes a chi-square test for association on the two-way table of counts in the specified *Observed* matrix. The null hypothesis H_0 for a two-way table is: no association exists between row variables and column variables. The alternative hypothesis is: the variables are related.

2-SampFTest

2-SampFTest (two-sample F-test) computes an F-test to compare two normal population standard deviations (σ_1 and σ_2). The population means and standard deviations are all unknown. **2-SampFTest**, which uses the ratio of sample variances $Sx1^2/Sx2^2$, tests the null hypothesis $H_0: \sigma_1=\sigma_2$ against one of the alternatives below.

- $H_a: \sigma_1 \neq \sigma_2$ ($\sigma_1:\neq\sigma_2$)
- $H_a: \sigma_1 < \sigma_2$ ($\sigma_1:<\sigma_2$)
- $H_a: \sigma_1 > \sigma_2$ ($\sigma_1:>\sigma_2$)

Below is the definition for the **2-SampFTest**.

$Sx1, Sx2$ = Sample standard deviations having n_1-1 and n_2-1 degrees of freedom *df*, respectively.

F = F-statistic = $\left(\frac{Sx1}{Sx2}\right)^2$

$df(x, n_1-1, n_2-1)$ = $Fpdf()$ with degrees of freedom *df*, n_1-1 , and n_2-1

p = reported *p* value

2-SampFTest for the alternative hypothesis $\sigma_1 > \sigma_2$.

$$p = \int_F^{\alpha} f(x, n_1-1, n_2-1) dx$$

2-SampFTest for the alternative hypothesis $\sigma_1 < \sigma_2$.

$$p = \int_0^{F'} f(x, n_1 - 1, n_2 - 1) dx$$

2-SampFTest for the alternative hypothesis $\sigma_1 \neq \sigma_2$. Limits must satisfy the following:

$$\frac{p}{2} = \int_0^{L^{bnd}} f(x, n_1 - 1, n_2 - 1) dx = \int_{U^{bnd}}^{\infty} f(x, n_1 - 1, n_2 - 1) dx$$

where: $[L^{bnd}, U^{bnd}]$ = lower and upper limits

The **F**-statistic is used as the bound producing the smallest integral. The remaining bound is selected to achieve the preceding integral's equality relationship.

LinRegTTest

LinRegTTest (linear regression *t* test) computes a linear regression on the given data and a *t* test on the value of slope β and the correlation coefficient ρ for the equation $y = \alpha + \beta x$. It tests the null hypothesis $H_0: \beta = 0$ (equivalently, $\rho = 0$) against one of the alternatives below.

- $H_a: \beta \neq 0$ and $\rho \neq 0$ (β & $\rho: \neq 0$)
- $H_a: \beta < 0$ and $\rho < 0$ (β & $\rho: < 0$)
- $H_a: \beta > 0$ and $\rho > 0$ (β & $\rho: > 0$)

Multiple Reg Tests (MultRegTest)

Multiple linear regression *t* test computes a linear regression on the given data, and provides the *F* test statistic for linearity.

Refer to the *TI-Nspire Reference Guide* for information about MultRegTests.

ANOVA

ANOVA (one-way ANalysis Of VAriance) computes a one-way analysis of variance for comparing the means of two to 20 populations. The **ANOVA** procedure for comparing these means involves analysis of the variation in the sample data. The null hypothesis $H_0: \mu_1 = \mu_2 = \dots = \mu_k$ is tested against the alternative H_a : not all μ_1, \dots, μ_k are equal.

The ANOVA test is a method of determining if there is a significant difference between the groups as compared to the difference occurring within each group.

This test is useful in determining if the variation of data from sample-to-sample shows a statistically significant influence of some factor other than the variation within the data sets themselves. For example, a box buyer for a shipping firm wants to evaluate three different box manufacturers. He obtains sample boxes from all three suppliers. ANOVA can help him determine if the differences between each sample group are significant as compared to the differences within each sample group.

ANOVA 2-way (ANOVA2way)

ANOVA 2-way computes a two-way analysis of variance for comparing the means of two to 20 populations. A summary of results is stored in the *stat.results* variable.


The two-way **ANOVA** analysis of variance examines the effects of two independent variables and helps to determine if these interact with respect to the dependent variable. (In other words, if the two independent variables do interact, their combined effect can be greater than or less than the impact of either independent variable additively.)

This test is useful in evaluating differences similar to the ANOVA analysis but with the addition of another potential influence. To continue with the ANOVA box example, the two-way ANOVA might examine the influence of box material on the differences seen.

Selecting an Alternative Hypothesis ($\neq < >$)

Most of the inferential stat editors for the hypothesis tests prompt you to select one of three alternative hypotheses.

- The first is a \neq alternative hypothesis, such as $\mu \neq \mu_0$ for the **Z-Test**.
- The second is a $<$ alternative hypothesis, such as $\mu_1 < \mu_2$ for the **2-SampTTest**.
- The third is a $>$ alternative hypothesis, such as $p_1 > p_2$ for the **2-PropZTest**.

To select an alternative hypothesis, move the cursor to the appropriate alternative, and then press .

Draw Option

Draw determines whether the test results are graphed. If you enable the check box, the page is split and the test curve and shading are graphed.

Selecting the Pooled Option

Pooled (2-SampTTest and 2-SampTInt only) specifies whether the variances are to be pooled for the calculation.

- Select **No** if you do not want the variances pooled. Population variances can be unequal.

- Select **Yes** if you want the variances pooled. Population variances are assumed to be equal.

To select the **Pooled** option, select Yes from the drop down box.

Statistics Input Descriptions

The following table describes the different inputs used in List & Spreadsheet wizards.

Input	Description
μ_0	Hypothesized value of the population mean that you are testing.
σ	The known population standard deviation; must be a real number > 0 .
List	The name of the list containing the data you are testing.
Frequency List	The name of the list containing the frequency values for the data in List . Default=1. All elements must be integers ≥ 0 . The frequency values can also be typed as a list, in the format {1, 1, 3, 2}.
\bar{x} , Sx , n	Summary statistics (mean, standard deviation, and sample size) for the one-sample tests and intervals.
σ_1	The known population standard deviation from the first population for the two-sample tests and intervals. Must be a real number > 0 .
σ_2	The known population standard deviation from the second population for the two-sample tests and intervals. Must be a real number > 0 .
List 1, List 2	The names of the lists containing the data you are testing for the two-sample tests and intervals.
Frequency 1 Frequency 2	The names of the lists containing the frequencies for the data in List 1 and List 2 for the two-sample tests and intervals. Defaults=1. All elements must be integers ≥ 0 .
\bar{x}_1 , Sx1 , n_1 , \bar{x}_2 , Sx2 , n_2	Summary statistics (mean, standard deviation, and sample size) for sample one and sample two in two-sample tests and intervals.
Pooled	Specifies whether variances are to be pooled for 2-SampTTest and 2-SampTInt . No instructs the TI-Nspire not to pool the variances. Yes instructs the TI-Nspire to pool the variances.
p_0	The expected sample proportion for 1-PropZTest . Must be a real number, such that $0 < p_0 < 1$.

Input	Description
x	The count of successes in the sample for the 1-PropZTest and 1-PropZInt . Must be an integer ≥ 0 .
n	The count of observations in the sample for the 1-PropZTest and 1-PropZInt . Must be an integer > 0 .
x1	The count of successes from sample one for the 2-PropZTest and 2-PropZInt . Must be an integer ≥ 0 .
x2	The count of successes from sample two for the 2-PropZTest and 2-PropZInt . Must be an integer ≥ 0 .
n1	The count of observations in sample one for the 2-PropZTest and 2-PropZInt . Must be an integer > 0 .
n2	The count of observations in sample two for the 2-PropZTest and 2-PropZInt . Must be an integer > 0 .
C-Level	The confidence level for the interval instructions. Must be ≥ 0 and < 100 . If it is ≥ 1 , it is assumed to be given as a percent and is divided by 100. Default=0.95.
df	df (degrees of freedom) represents (number of sample categories) - (number of estimated parameters for the selected distribution + 1).
RegEQ	The prompt for the name of the function where the calculated regression equation is to be stored.

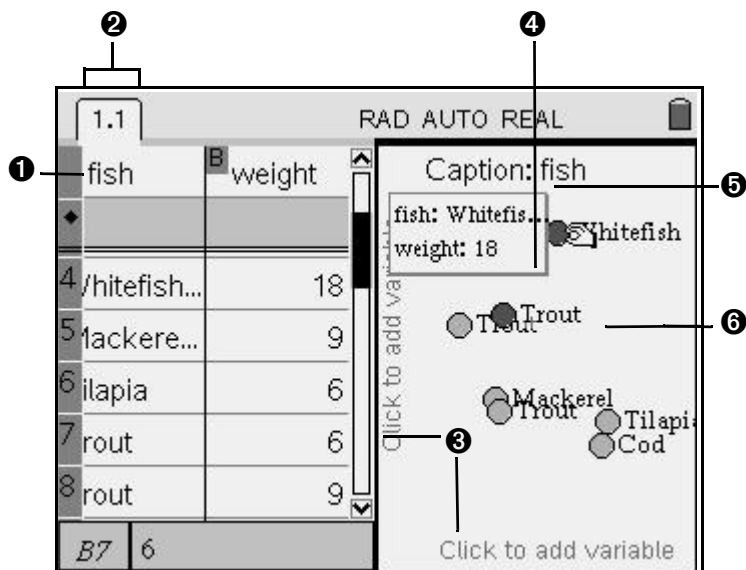
Using Data & Statistics

The Data & Statistics application provides tools to:

- Visualize sets of data in different types of plots.
- Directly manipulate variables to explore and visualize data relationships. Data changes in one application are dynamically applied to all linked applications.
- Explore central tendency and other statistical summary techniques.
- Fit functions to data.
- Create regression lines for scatter plots.
- Graph hypothesis tests and results (z- and t-tests) based on summary statistics definitions or data.


Data & Statistics plots numeric and string (categorical) data from variables. You can create these variables (also called lists) in a Lists & Spreadsheet or Calculator application. When a problem includes lists, a default caption and case plot display on the Data & Statistics work area. You can use the defaults to explore grouping the data. Click the caption to see variable names used to label data, click and hold a single point to see the summary information, or drag a point to see how the points group.

Adding a variable to an axis makes the dots in the case plot move into position based on the values in the selected list. In their final position, the dots display in the default plot type for the types of data.




- ❶ Lists & Spreadsheet application (list contains data for variables)
- ❷ Problem/Page number counter
- ❸ Add variable regions on x-axis and y-axis
- ❹ Case plot summary (shows information from a spreadsheet row)
- ❺ Caption shows the label of the first categorical list, by default; click to change this variable.
- ❻ Sample Data & Statistics work area (case plot for the variable named in the caption displays by default)





The Tool menu

Press  to open the Tools menu. These menus and tools enable you to graph and explore data, modify data presentations by using different plots, as well as perform and plot statistical analyses.








The following tables describe what each tool does in the Data & Statistics work area.



Tool Menus

Menu	Overview of Tool Actions
 1: Plot type	Provides access to the different plot types available in the Data & Statistics application.





Menu	Overview of Tool Actions	
 2: Plot Properties	Allows you to specify how the plot displays.	
 3: Actions	Lets you remove objects, hide or insert text, insert a slider, and select all points in the work area.	
 4: Analyze	Lets you analyze data by fitting lines and functions, and by examining regressions, summary statistics, and residuals. You can also use the Plot Value, Show Normal PDF, and Graph Trace tools from the Analyze menu.	
 5: Window Zoom	Lets you specify a zoom factor for the window, or determine min and max values for the horizontal and vertical axes.	









Plot Types Menu Tools

Tool name	Tool function
 1: Dot Plot	Depicts data in a dot plot. This is the default plot type for a single numeric variable.
 2: Box Plot	Displays data in a box plot.
 3: Histogram	Displays data in a histogram.
 4: Normal Probability Plot	Displays data in a normal probability plot. Data is grouped against the z-value that corresponds to its quartile/normal score. This plot type is useful for checking for normality and determining the appropriateness of a normal model.
 5: Scatter Plot	Displays data in scatter plot form. This is the default plot type for two numeric variables.
 6: X-Y Line Plot	Displays data as an x-y line plot.
 7: Dot Chart	Displays data in a dot chart. This is the default plot type for categorical data.






Tool name	Tool function
 8: Bar Chart	Displays vertical or horizontal bars to represent cases in categories of data.
 9: Pie Chart	Displays a circle with segments to represent the cases in each category of data.

Plot Properties Menu Tools






Tool name	Tool function
 1: Connect Data Points	Draws a line between each point on a scatter plot. Lines are connected in the order in which the data appears for the variable on the horizontal axis. This is the same as the X-Y Line plot type.
 2: Histogram Properties	Determines how histogram data displays in the work area.
Count	Displays data in the histogram by occurrence in the data set.
Percent	Displays data in the histogram by each bin's percent value of the whole data set.
Density	Displays data in the histogram by data density.
Bins	Displays a dialog for setting the histogram values for bin width and alignment.
 3: Extend Box Plot Whiskers/ Show Box Plot Outliers	<p>Extend Box Plot Whiskers extends the whiskers to the min and max of the data.</p> <p>Show Box Plot Outliers stops the whiskers at $1.5 * \text{Interquartile Range}$ and shows outliers as individual dots.</p> <p>Note: If there are no points outside of $1.5 * \text{Interquartile Range}$, there may appear to be no whisker change.</p>
 4: Add X Variable	Adds a variable to the horizontal axis when no variable is assigned.


Tool name	Tool function
 5: Remove X Variable	Removes the display of the variable assigned to the horizontal axis without changing the vertical axis.
 6: Add Y Variable	Adds a variable to the vertical axis to support the plotting of multiple variables.
 7: Remove Y Variable	Removes the display of the variable assigned to the vertical axis without changing the horizontal axis.
 8: Force Numeric X	Treats the variable on the x-axis as numeric although the default is categorical (list of strings). The categorical data label is replaced by an axis with numbers. Note: Forcing a numeric variable is supported only when there are numbers in the list.
 9: Force Numeric Y	Treats the variable on the y-axis as a numeric variable although the default is categorical (list of strings). The categorical data label is replaced by an axis with numbers. Note: Forcing a numeric variable is supported only when there are numbers in the list.
 8: Force Categorical X	Treats the variable on the x-axis as a categorical variable (list of strings). The numeric axis is replaced by labels for categorical data.
 9: Force Categorical Y	Makes Data & Statistics treat a numeric variable assigned to the y-axis as a categorical variable (list of strings). The numeric is replaced by labels for categorical data.
 A: Clear All	Removes the variable assignments from the axes. This enables you to start your work again.







Actions Tool menu

Tool name	Tool function
 1: Remove	Removes selected items from the work area.
 2: Hide/Show Text	Hides or shows selected text.
 3: Insert Text	Adds a text box with multiple lines for typing notes in the work area. You can edit, move, resize, remove, and hide text boxes. Note: To go to the next line in a text box, press ↵.
 4: Insert Slider	Inserts a slider control for dynamically changing the value of a numeric variable.
 5: Select all Points	Selects all points in the work area.





Analyze Menu Tools

Tool name	Tool function
 1: Remove	Removes a selected Movable Line, Regression, Plotted Value, or Plotted Function.
 2: Add Movable Line	Adds a line you can position and reposition in the work area. This can be used for manual fit.
 3: Lock Intercept at Zero/Unlock Movable Line Intercept	Locks the intercept of a movable line at zero. Note: This tool is only available when a movable line is present in the work area.
 4: Plot Function	Lets you graph a function in the work area.
 5: Shade Under Function	Lets you select and shade a region under a function or distribution curve.

Tool name	Tool function
 6: Regression	The regression tools perform the selected regression calculation and then plot the regression model. Regression is only available on Scatter plots or X-Y line plots.
Show/Hide Linear (mx+b)	Calculates and displays the linear regression line in the format, $mx+b$, for the plotted data.
Show/Hide Linear (a+bx)	Calculates and displays the linear regression line in the format, $a+bx$, for the plotted data.
Show/Hide Median-Median	Calculates and displays the Median-Median regression line for the plotted data.
Show/Hide Quadratic	Calculates and displays the Quadratic regression model for the plotted data.
Show/Hide Cubic	Calculates and displays the Cubic regression model for the plotted data.
Show/Hide Quartic	Calculates and displays the Quartic regression model for the plotted data.
Show/Hide Power	Calculates and displays the Power regression model for the plotted data.
Show/Hide Exponential	Calculates and displays the Exponential regression model for the plotted data.
Show/Hide Logarithmic	Calculates and displays the Logarithmic regression model for the plotted data.
Show/Hide Sinusoidal	Calculates and displays the Sinusoidal regression model for the plotted data.

Tool name	Tool function
Show/Hide Logistic (d=0)	Calculates and displays the Logistic regression model where $D=0$, for the plotted data.
Show/Hide Logistic (d \neq 0)	Calculates and displays the Logistic regression model where $D\neq 0$, for the plotted data.
 7: Residuals	The residuals tools display information about the residuals of the selected model.
 Show/Hide Residual Squares	Displays the squares of residuals. Note: This tool is available when a regression line or movable line is present in the work area.
 Show/Hide Residual Plot	Plots the residuals against the explanatory variable. The residual is the difference between the observed value (data) and the value calculated by a regression or function. Note: This tool is available when a scatter plot and one or more lines, regressions, or plotted functions are on the work area.
 8: Plot Value	Lets you graph a statistical value on the axis. Examples of values that can be plotted are mean, median, standard deviation.
 9: Show Normal PDF	Overlays the normal probability density function using the mean and the standard deviation of the data in the histogram. Note: This tool is available when a histogram is present.
 A: Graph Trace	Lets you trace the graph from Plot Function, Show Normal PDF, distribution curves, or regressions.

Window/Zoom Menu Tools

Tool name	Tool function
 1: Window Settings	Displays a Window Settings dialog that enables you to enter values that define the work area window. Values you can set include the x-min, x-max, y-min, and y-max values for the axes.
 2: Zoom - Data	Adjusts the zoom factor so that all plotted data appears in the work area.
 3: Zoom In	Enables you to zoom in on a plot based upon the selection of a center point. The Zoom In factor is approximately 2.
 4: Zoom Out	Enables you to zoom out on a plot based upon the selection of a center point. The Zoom Out factor is approximately 2.

Getting started with Data & Statistics

The Data & Statistics application is a place to explore and visualize data and graph inferential statistics. It is, therefore, best used in conjunction with a numerical application like Calculator or Lists & Spreadsheet. You can plot data from Lists & Spreadsheet using the Quick Graph tool, or by adding a new Data & Statistics page to the problem and plotting variables on the axes.

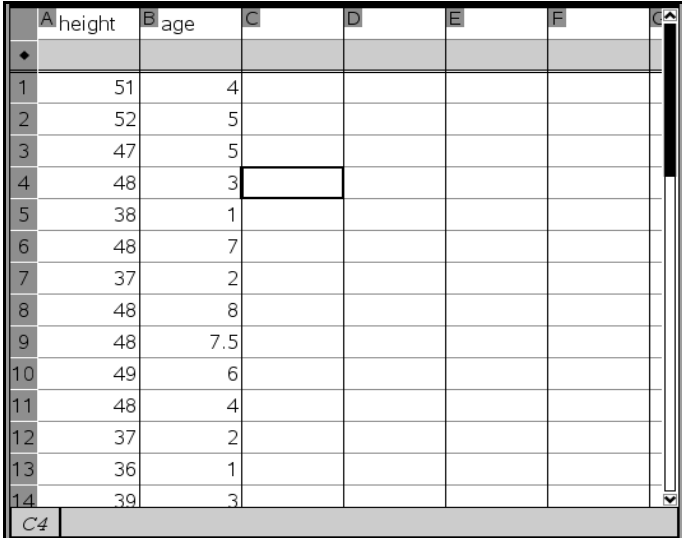
Creating plots from spreadsheet data

The **Quick Graph** tool of Lists and Spreadsheet is the easiest way to plot data using the columns in a spreadsheet.

Plotting data using the Quick Graph tool

1. Open a problem that includes a Lists & Spreadsheet page, or create data to be plotted in Lists & Spreadsheet. You can plot one or two columns of data.


The following example shows two columns (lists), **height** and **age**.






The image shows a spreadsheet with columns labeled 'height' and 'age'. The data is as follows:

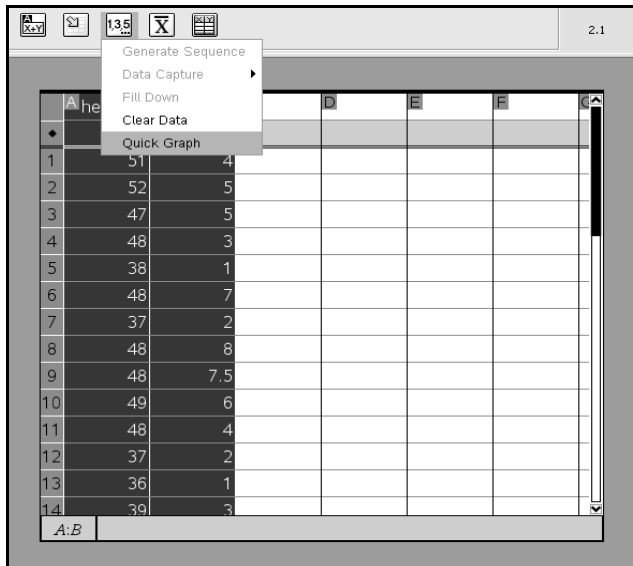
	A height	B age	C	D	E	F
1	51	4				
2	52	5				
3	47	5				
4	48	3				
5	38	1				
6	48	7				
7	37	2				
8	48	8				
9	48	7.5				
10	49	6				
11	48	4				
12	37	2				
13	36	1				
14	39	3				

Important: You must type a name for each column of data in Lists & Spreadsheet in order to plot the data in Data & Statistics.

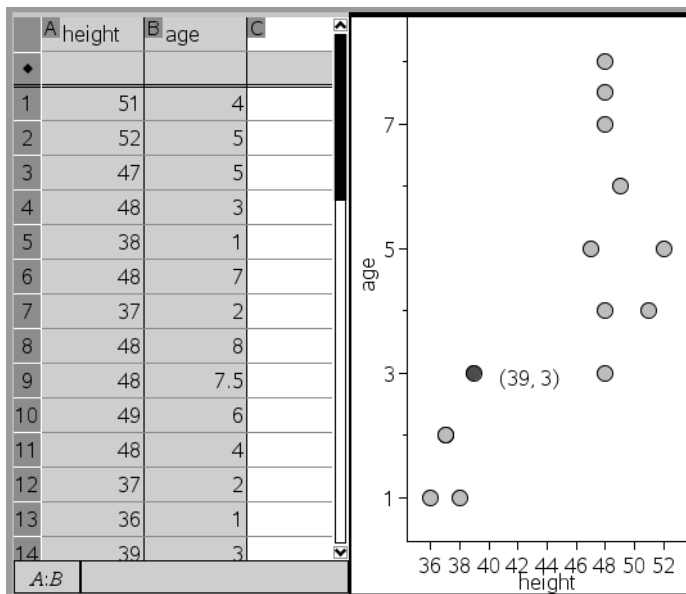
2. To highlight a single column, move to the top of the column and click ▲. . To select two columns, press  and use the NavPad arrows to include the next column in the selection.

3. From the Lists & Spreadsheet **Data** menu , select the **Quick Graph** tool.

Press   .



The Quick Graph tool adds a Data & Statistics page, plots the first column on the horizontal axis, and plots the second column on the vertical axis. The name for the column in Lists & Spreadsheet is the label for the axis it plots on. The following example shows the scatter plot for the two columns of data.



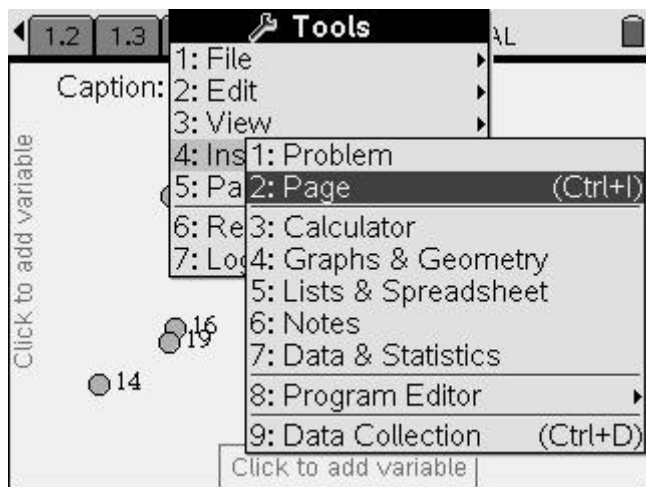
The data plot functions as follows:

- To create a dot plot on the horizontal axis, select only one column of data when using the Quick Graph tool. The column name appears as the horizontal axis label.
- To add a new work area with Data & Statistics active when using Quick Graph, confirm that fewer than four work areas are on the page. If four work areas are already on the page, Quick Graph adds a new page with Data & Statistics active on it.
- Click a point to select it. Clicking and holding the point displays the spreadsheet row information.
- Move to the add variable region of an axis. Click Click to change variable to display a list of other variables in the problem. Click any variable in the list to replace the current variable with your selection.

Note: If a list is defined with a formula in Lists & Spreadsheet, the points in Data & Statistics may not move because of the formula's restrictions. The dots in Data & Statistics only move in directions allowed by their definition. Dots that are defined by data in the cell move freely. Points that represent a calculation move as defined by the calculation. For example, a dot that represents the result of $y=x$ will move along a line.

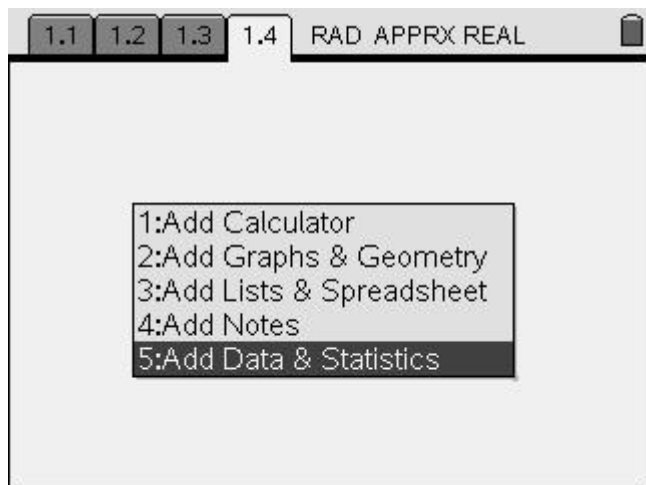
Plotting data on a new Data & Statistics page

1. Open a problem that includes lists defined in a Lists & Spreadsheet or Calculator application.
2. Press **Ctrl** + **⌘** and select **Page** on the **Tools** menu to add a page to the problem.



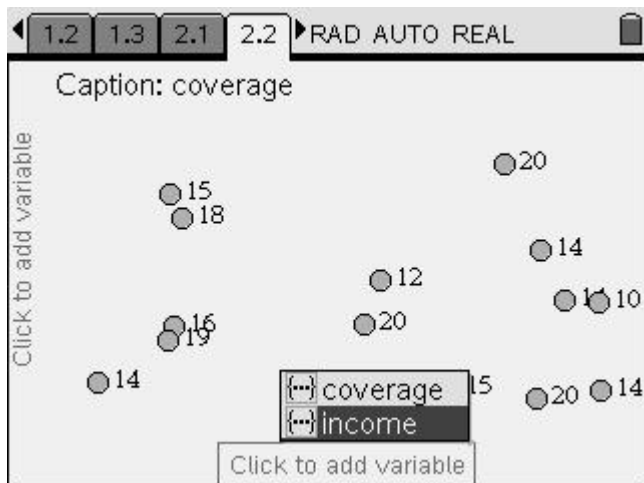
A blank page is added to the problem.

3. If necessary, click **menu** to see the list of applications. Click the tool tip in the center of the blank page to add a Data & Statistics application.



A Data & Statistics work area is added to the page.

By default, a caption at the top of the work area identifies an available variable in the problem and shows data points. You can click the add variable region on the caption to see data points for a different variable (that is, a named column in a list from any Lists & Spreadsheet page in the problem).

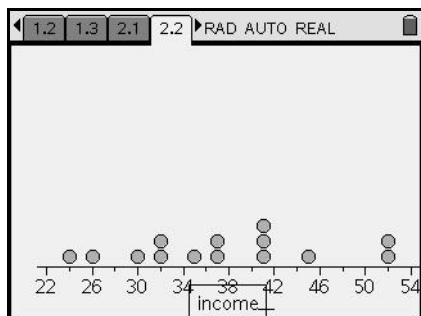


All variables from any Lists & Spreadsheet page in the problem display on the context menu for the horizontal axis.

When no variable is specified for an axis, the case plot provides the following details:

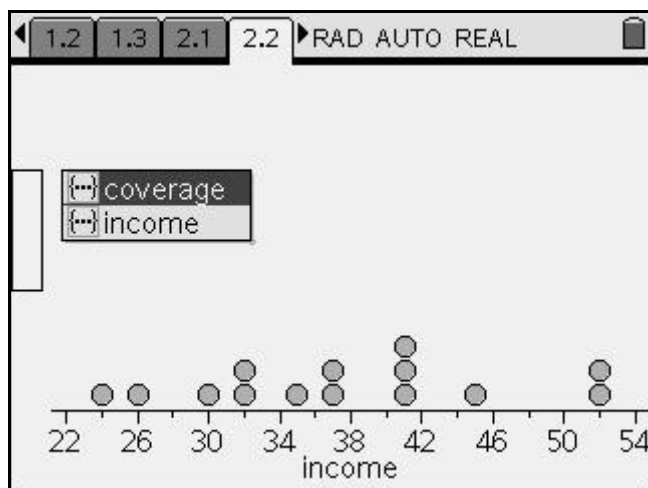
- Clicking and holding a dot in the plot displays the data for the corresponding case. A case corresponds to a row in Lists & Spreadsheet. In the following example, an annual income and a coverage amount comprise a case.
- Grabbing and dragging a dot in the plot causes all of the dots in the plot to shift appropriately based on the caption.
- Moving to an axis and clicking lets you see a list of all variables in the problem. Click on the name of any list to replace the variable on the axis with the variable in the selected list.

4. Click **income** to add the variable with that name to the horizontal axis.

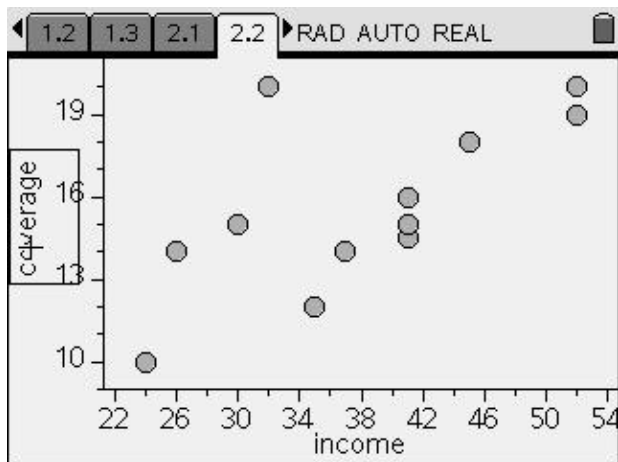


The following changes occur in the work area:

- The variable name, **income**, is added as the label for the horizontal axis.
 - Data points for the numeric value from each cell in the income column move into place on the x-axis.
5. Click the add variable region on the vertical axis to add a list from any page in the problem.



6. Click **coverage** to add the variable with that name to the vertical axis.



The dots move into place to show the coverage amount associated with each income. The variable name, **coverage**, is added as the label for the vertical axis.

Note: The context menu for each axis includes the option to **Force Categorical X** or **Force Categorical Y**. Forcing categorical treatment on an axis with a numeric variable replaces the numbers on the axis scale with the values from the cells for the spreadsheet column. A data point indicates each instance of a value.

Numeric plot types

Plots let you visualize your variable in a variety of ways. Visualizing the data points allows you to observe the shape and spread of the data, and can help you determine the best method of statistically evaluating data. Use Data & Statistics to create the following types of numeric plots:

- Dot Plot
- Box Plot
- Histogram
- Normal Probability
- Scatter Plot
- X-Y Line

Dot plots

Dot plots, also known as dot-frequency plots, represent one variable data. Dot plots are the default plot type for numeric data.




When one variable is plotted, the value of each cell is represented as one dot, and the dots are stacked at the point on the axis that corresponds to the cell value. By default, the horizontal axis is selected. The column name is used as the axis label.

Creating a dot plot

1. Create and name a list of data in a column in Lists & Spreadsheet or Calculator.
2. To create a dot plot, do one of the following:

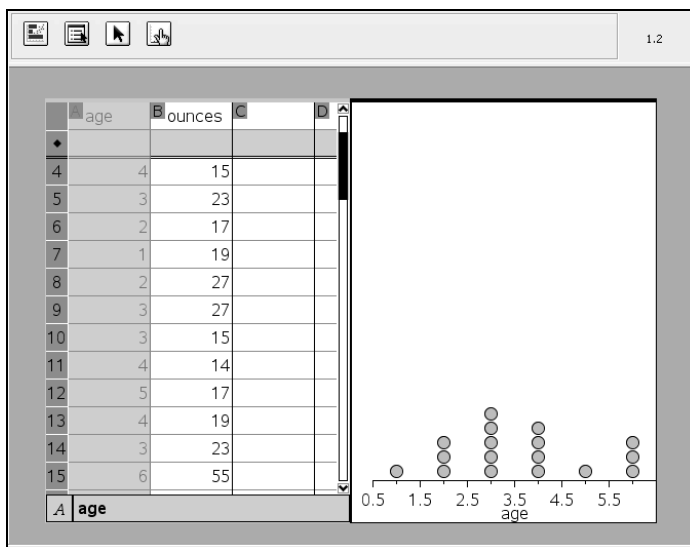
- Select the column of data in Lists & Spreadsheet by clicking the column letter near the header cell. You can click with the Navpad to move to the top of the current column. Click with the Navpad again to select the column.

In the Lists & Spreadsheet work area, select **Quick Graph** from the Data tool menu to automatically graph the selected data.

Press   .


Or

- Click in the horizontal axis label in the Data & Statistics work area, click and select the name of the variable containing the data you want to see represented on the horizontal axis.
3. The data graphs in the Data & Statistics work area.



Click on any dot to display its value, or click and drag to change its value. To deselect, click any area of the plot that does not include a dot.

Box plots

The default box plot created by the Box Plot Tool  is a modified box plot. It plots one-variable data. "Whiskers" extend from each end of the box, either 1.5 times the interquartile range or to the end of the data, whichever comes first. Points that are $1.5 \times \text{Interquartile Range}$ beyond the quartiles are plotted individually beyond the whisker. (The Interquartile Range is defined as the difference between the third quartile, Q3, and the first quartile, Q1.) These points are called potential outliers.

When no outliers exist, x -min and x -max are the prompts for the end of each whisker (the prompts will be y -min and y -max if you choose to create a vertical box plot). Q1, Med (median), and Q3 define the box.

Box plots are useful in comparing two or more sets of data. Note that these must use the same scale. If a dataset is large, a box plot can also be useful in exploring data distribution.




Creating a box plot

1. Using a problem that includes Lists & Spreadsheets data and a Data & Statistics work area, plot a variable on the horizontal axis.

Note: If two variables are plotted in the work area, select **Remove Y**

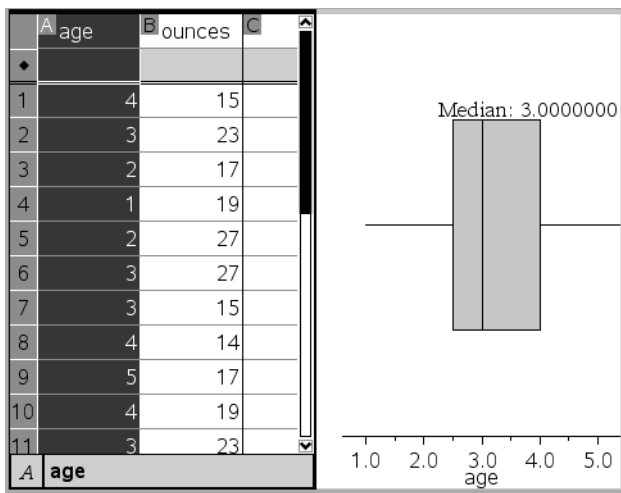
Variable  from the **Plot Properties** menu .

2. From the **Plot Types** menu , select the **Box Plot** tool .

Press   .

The default data points move into a modified box plot on the Data & Statistics work area.

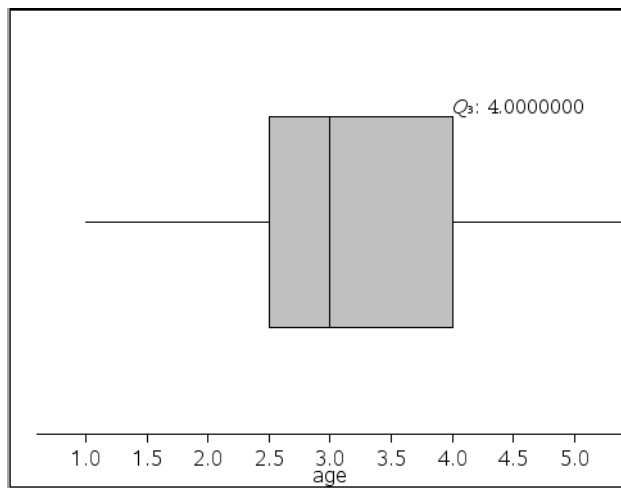
For a work area with no variable plotted, the caption and default data points move. A modified box plot displays on the Data & Statistics work area.



Initial box plot display - modified box plot

3. Hover on a box or whisker to display the details for the portion of the plot that interests you.

The label for the quartile that corresponds to your selection displays on the work area.







Box plot with label for Quartile 3




Creating a standard box plot

You can create a standard box plot by modifying the whiskers of the default (modified) box plot. In a standard box plot, the whiskers are plotted using the minimum and maximum points in the variable. No attempt is made to identify outliers.

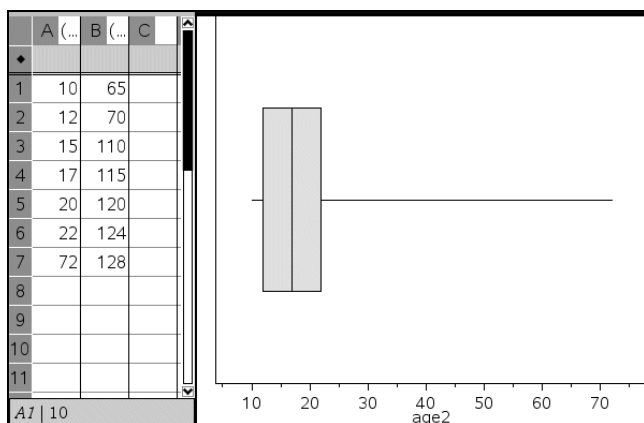
The whiskers on the plot extend from the minimum data point in the set (x -min) to the first quartile (Q1) and from the third quartile (Q3) to the maximum point (x -max). The box is defined by Q1, Med (median), and Q3.

To change the box plot from modified to standard:




1. Create a box plot for one variable by selecting the Box Plot tool  from the **Plot Types** menu .
2. Display the context menu for the box plot:
 - Move the cursor to the box plot and then press  .
3. Select **Extend Box Plot Whiskers**.

Press   .

The box plot is redrawn to display the whiskers you selected.



4. To return the box plot to its original display, display the context menu and select **Show Box Plot Outliers**.

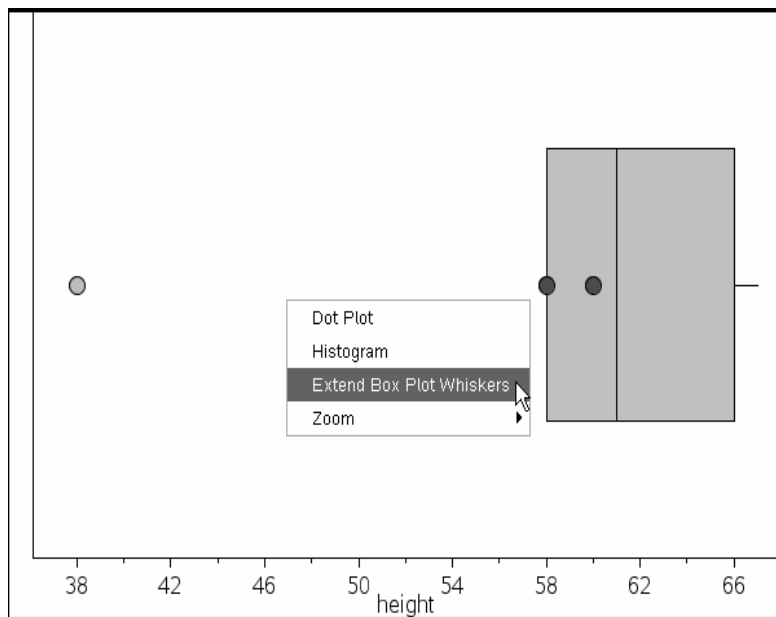
Press   .

Extending Box Plot Whiskers

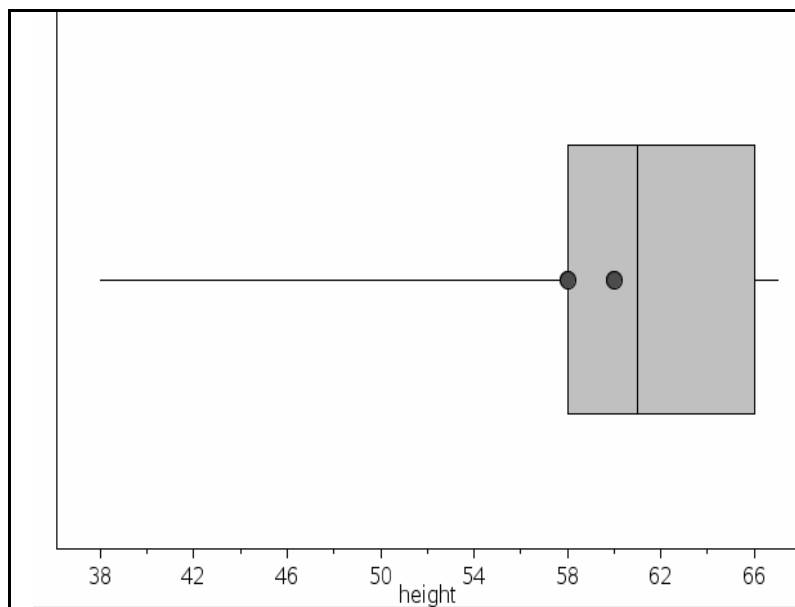
You can select **Extend Box Plot Whiskers** from the **Plot Properties** menu




to extend the whiskers to the min and max of the data. You can also select **Extend Box Plot Whiskers** from the context menu, as shown in the example below.

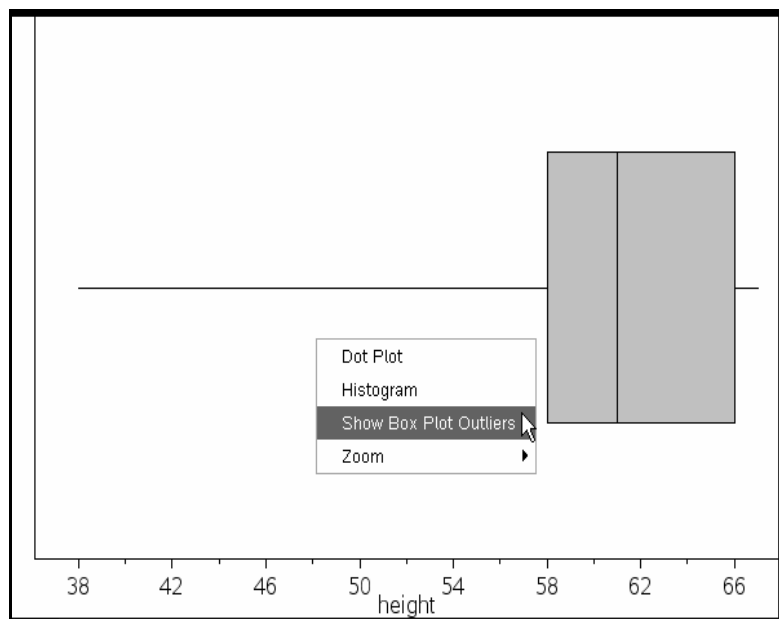


The whiskers extend to the min and max of the data.

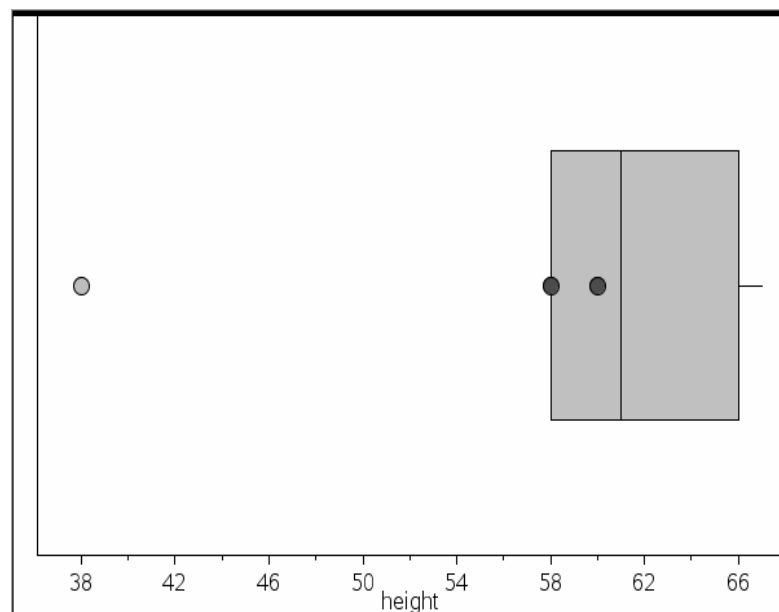


Showing Box Plot Outliers

Select **Show Box Plot Outliers** from the **Plot Properties** menu  to stop whiskers at $1.5 \times$ Interquartile Range and show outliers as individual dots. You can also select **Show Box Plot Outliers** from the context menu.



Points beyond $1.5 \times$ Interquartile Range display in the work area as outliers.

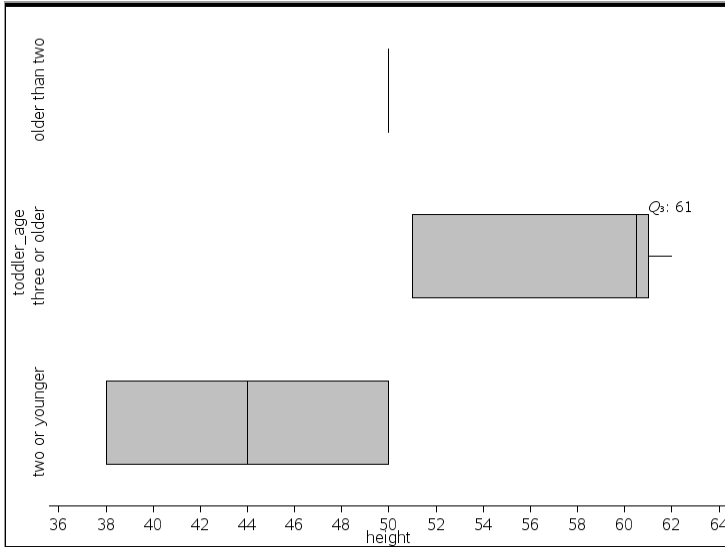


Note: If there are no points outside of $1.5 \times$ Interquartile Range, there may appear to be no change in the whisker display.

Multiple box plots

When you have a numeric list with a corresponding categorical list, you can create a box plot split by category. Adding the categorical list splits the box plot by category. A split box plot is useful for comparing the spread of various populations.

In the following example, the text that describes a toddler age range is used to sort the heights in the box plots:



Note: Histograms and dot charts can also be split by category by adding the corresponding categorical variable to a plot of the numeric variable.

Histograms

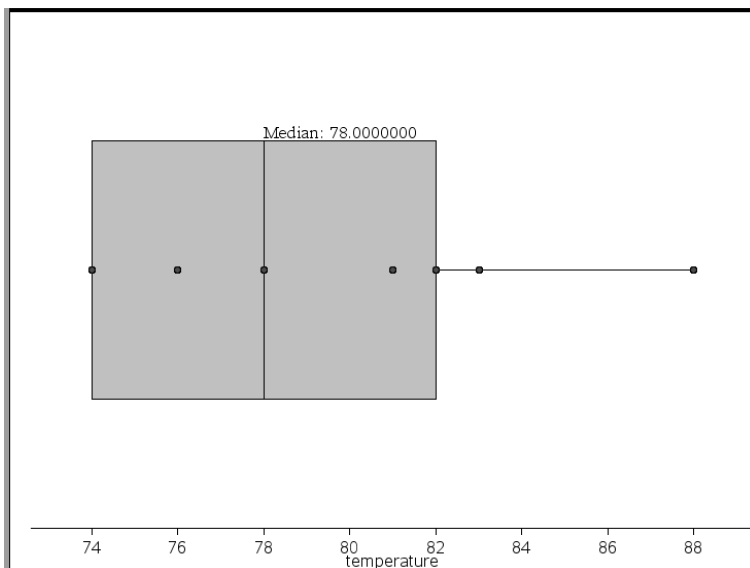
A histogram plots one-variable data. Histograms depict the distribution of data.



The number of bins displayed depends upon the number of data points and the distribution of these points. You can adjust the bins' width and number by dragging the side of one bin in the work area.

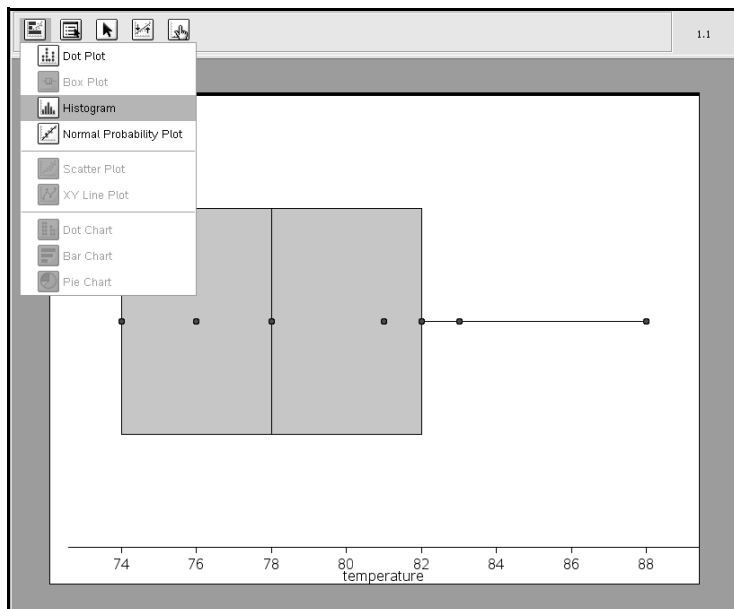
A value that occurs on the edge of a bin is counted in the bin to the right.

Creating a histogram

1. Select the data you want to plot as a histogram.

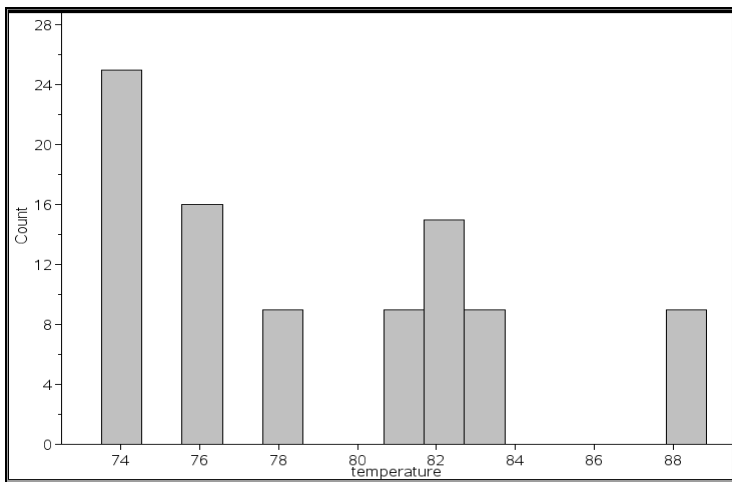


2. From the **Plot Types** menu , select the **Histogram** tool . Press **(menu)** **1** **3**.



In this example, the data from the box plot separates into points and moves to form the bins of a histogram.

The histogram plots on the Data & Statistics work area.



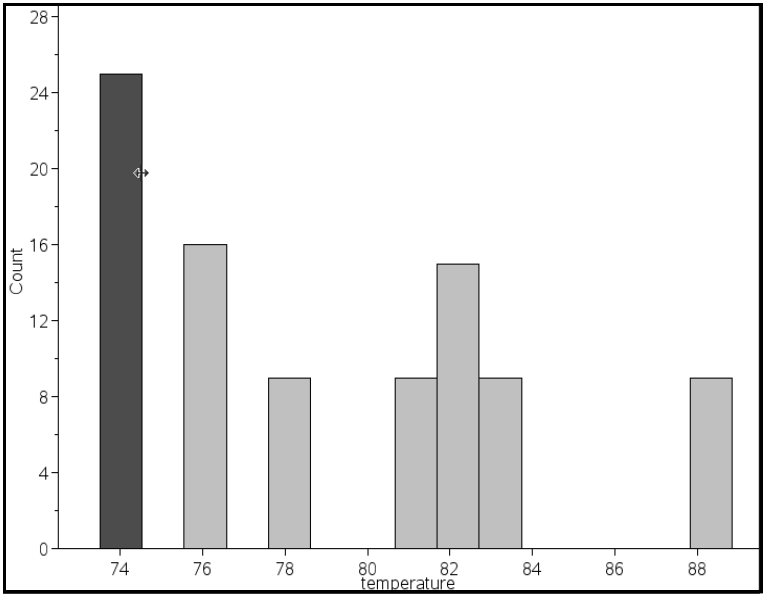
Initial histogram display



3. Click on any bin to select it. Click and hold a bin to display the summary information.

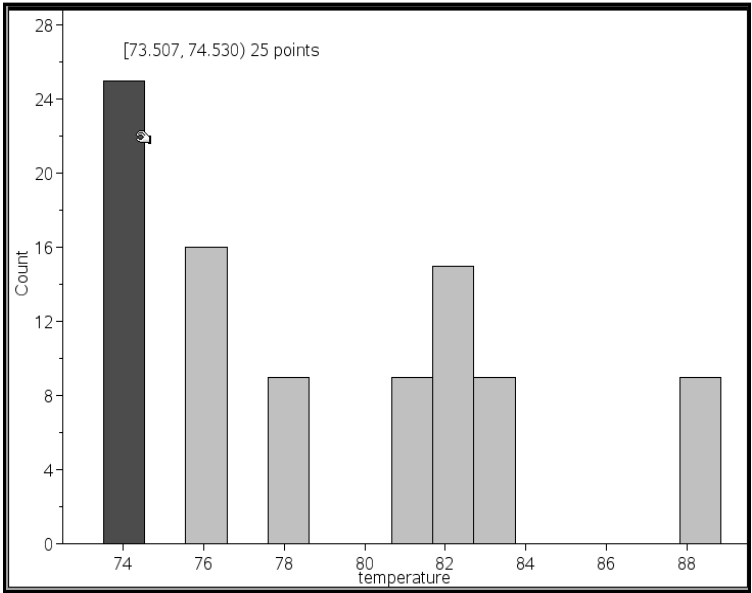
Adjusting the bins interactively

1. Hover over the right side of the bin.



The cursor changes to \leftrightarrow .



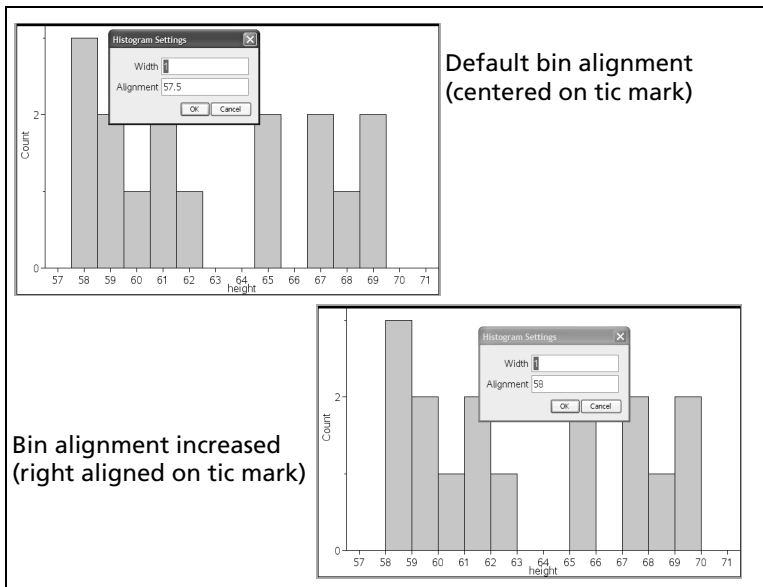
- Press and hold  to display the grab cursor . Move the edge to the desired bin width and release it.



Adjusting bins numerically

1. From the **Plot Properties** menu () , select **Histogram Properties** ().
2. Select **Bin Settings**. The **Histogram Properties** dialog displays.
3. Type values to set width and alignment of the bins that represent histogram data:
 - To specify bin width, type a value in **Width**.
 - To specify bin placement, type a value in **Alignment**.

The bins of the histogram are redrawn using the values set. Both the data represented by the bins and the value you type for the alignment affect the placement of bins on the scale.

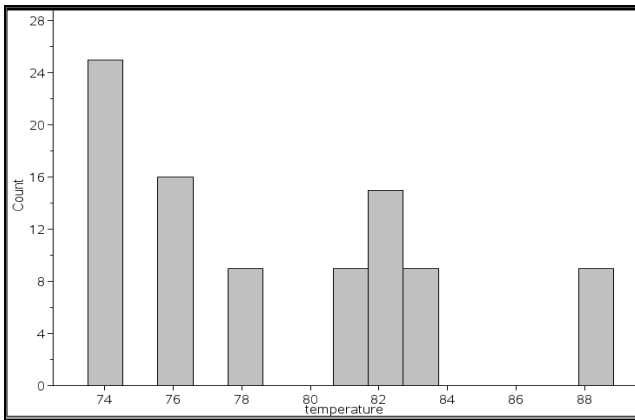


For example, when a histogram with a bin width of 1 is centered over the tic marks on the axis with the default alignment of 57.5, changing the alignment to 58 left aligns all bins on the axis scale. All bins are shifted right by .5; the offset for positioning bins on the axis is based on the starting position for the data and the value you specify for alignment.

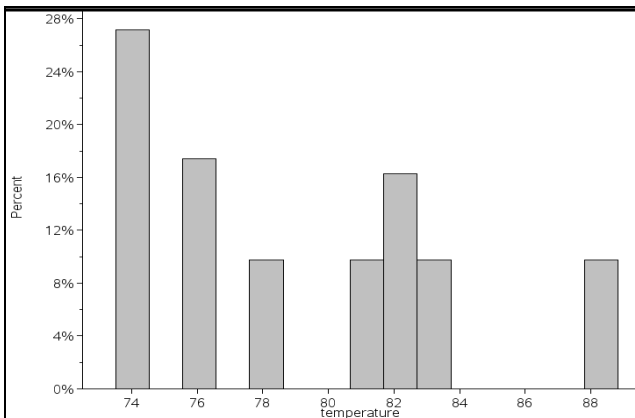
Changing the properties of a histogram:

Use the histogram properties tools to change the data representation format in a histogram. The options for properties are:

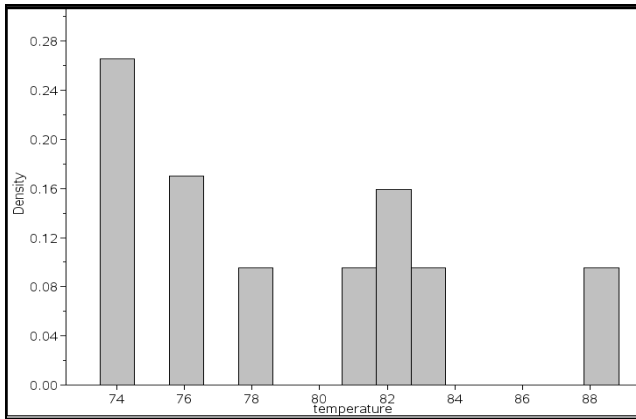
- **Count** - displays data based upon the number of values that occur within each bin (interval) on the histogram. This is the default data representation when you create a histogram.



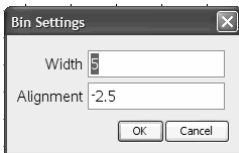
- **Percent** - displays data in the histogram by each group's percent value of the whole data set.



- **Density** - displays data based upon the density of each value within the variable.



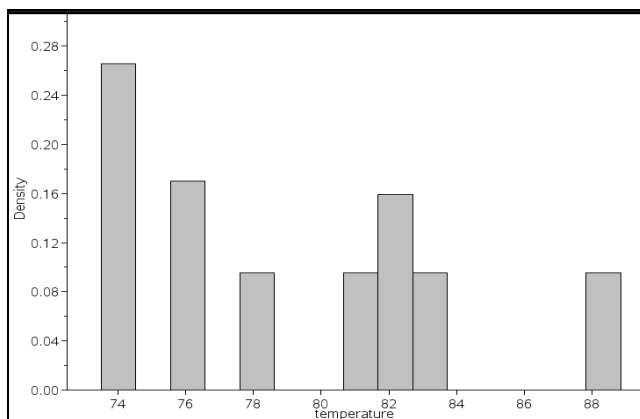
- **Bin Settings**- displays the **Bin Settings** dialog box. To adjust the histogram, type a numeric value for the width and alignment of histogram bins.








Setting the bin width and alignment requires consideration of both the number of bins and the number of data points included in the range represented by a bin. Avoid misrepresentation by accepting the default bin width or experimenting to identify appropriate bin settings.

To change the scale:

1. Create a histogram.



2. Display the context menu for the histogram:
 - Move the cursor to the histogram and then press  .
3. Select **Scale** from the context menu.
4. Select **Percent** () or **Density** (). The histogram is redrawn to the scale you select.

Note: The Count tool () is not available because it is the scale currently used in the display.



Click on a bin to display the values that are contained in the bin.

Normal probability plots

A normal probability plot shows one set of data against the corresponding quartile (z) of the standard normal distribution. You can use normal probability plots to judge the appropriateness of the normal model for your data.

Creating a normal probability plot

1. Select the data you want to use for a normal probability plot. Use a named list from Lists & Spreadsheet or Calculator.
2. Plot the data in one of the following ways:
 - Create a dot plot by selecting a column and choosing **Quick Graph**.
 - Add a Data & Statistics work area and assign the data list name as the variable for an axis.

- From the **Plot Types** menu , select **Normal Probability Plot** .
- The data graphs in the Data & Statistics work area.

You can examine the graph to compare the normal variable against the quartile. Click on a dot to display its value.




Scatter Plots

A scatter plot shows the relationship between two variables of the data or two sets of data.

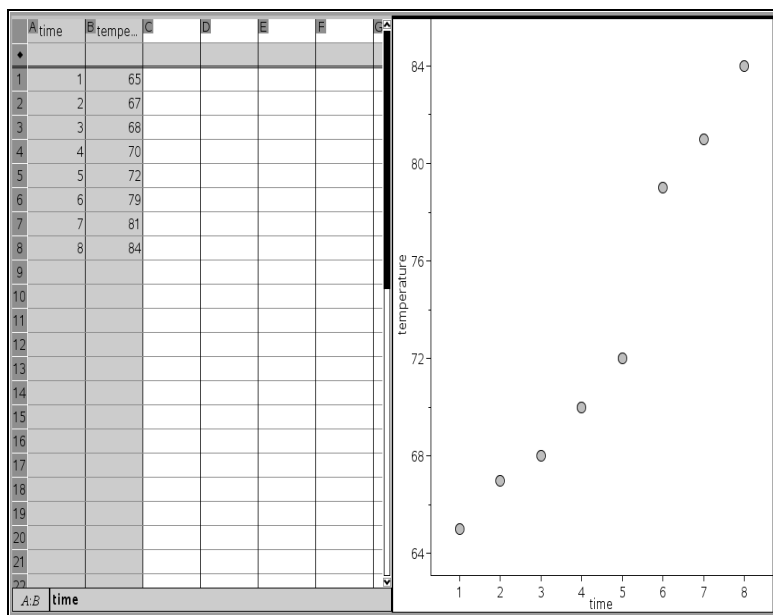
You can plot bivariate data in either of two ways.

From the Lists & Spreadsheet work area:

- Select two columns of data listed in Lists & Spreadsheet by clicking the letter above the first column and pressing **Shift** and using the arrow keys to include the adjacent column in the selection.
- Select **Quick Graph** from the **Data** menu to automatically graph the selected data.

Press   .

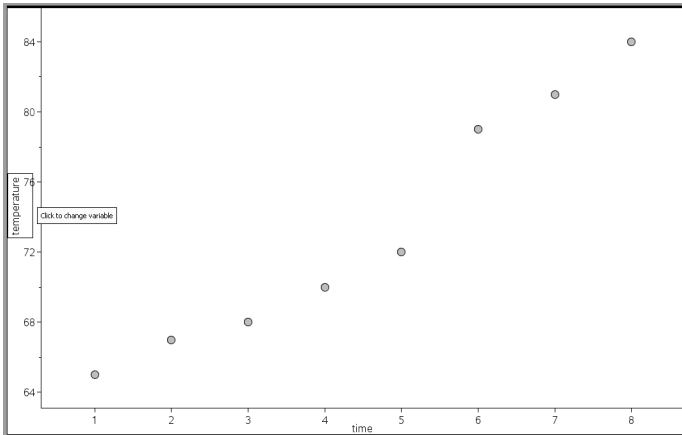
The data graphs on the Data & Statistics work area.



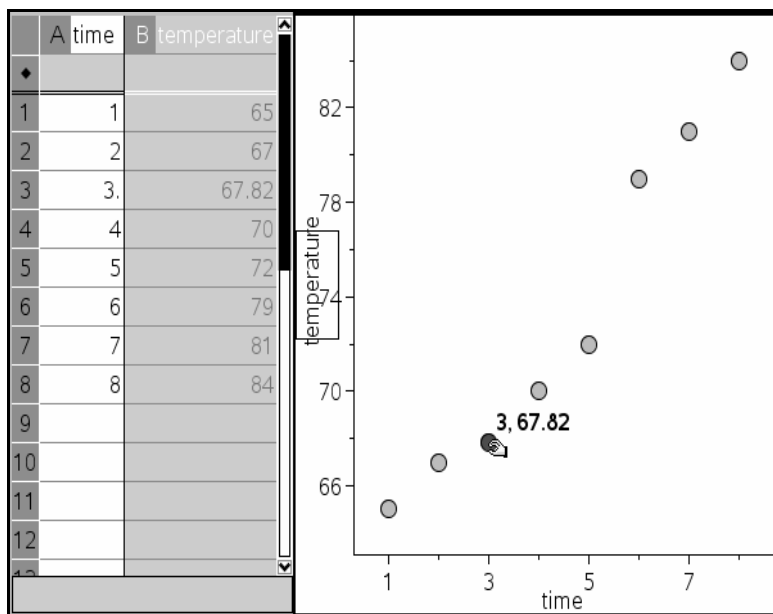
From the Data & Statistics work area:

1. In the Data & Statistics work area, click in the horizontal axis label box, and select the variable that contains the data you want to see represented on the horizontal axis.
2. Click the add variable region of the vertical axis and select the variable that contains the data you want to see represented.

The data graphs in the Data & Statistics work area.








3. Click on any point to display its value.

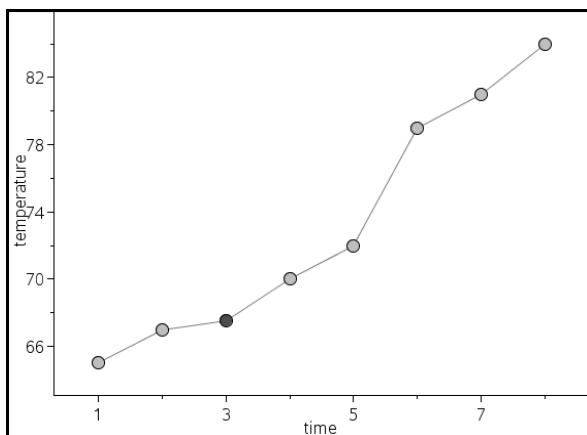


X-Y line plots

An X-Y line plot is a scatter plot in which the data points are plotted and connected in order of appearance in the two variables. Like scatter plots, these plots depict the relationship between two sets of data.

By convention, the left-most column of data is represented on the horizontal axis.

1. Create a scatter plot using the steps shown in the previous sections.
2. From the **Plot Types** menu , select the XY Line Plot tool .
Press   .
3. The data points within each set are connected to each other by a line.





Note: The dots are connected in the order that they appear in the list variable on the horizontal axis. To change the order, use the sort tool in Lists & Spreadsheet.

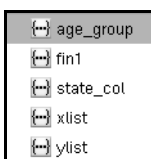
Creating multiple plots

1. From a Lists & Spreadsheet work area, create a scatter plot using two columns of data.

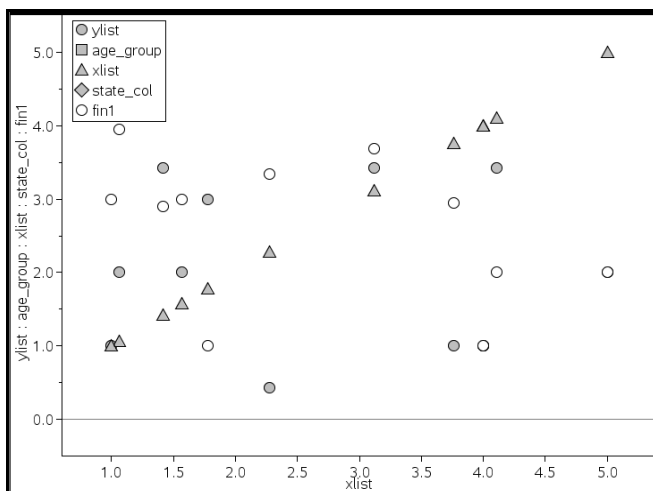
For more information, refer to the previous section, "Scatter plots."

2. From the **Plot Properties** menu () , select **Add Y Variable**  .

A list of the names of all variables available in the problem displays.



3. Use the arrow keys to move to and click the name of the variable that you want to plot in addition to the data previously plotted on the y-axis.



After you select a second variable for plotting, a legend displays at the top of the work area. The legend shows the clear shapes and shaded shapes used to distinguish the multiple variables plotted on the y-axis.

Click on the legend to hide it, or to remove one of the variables plotted on the y-axis. Click and grab the legend to move it to another position in the work area.

To add more variables to the y-axis, repeat steps 2 and 3.

Categorical plot types

You can sort and group data using the categorical plot types:

- Dot Chart
- Bar Chart
- Pie Chart

The categorical plot types can be used to compare the representations of data across different plots. When the same variable (list) is used for a dot chart and a bar chart or pie chart in a problem, selecting a data point or segment in one of the plots selects the corresponding data point, segment, or bar in all other plots that include the variable.

Dot charts

Dot charts summarize data that is categorical. The default plot type for categorical data in Data & Statistics is the dot chart.

When one variable is plotted, the value of each cell is represented as one dot, and the dots are stacked at the point on the axis that corresponds to the cell value.

Creating a dot chart

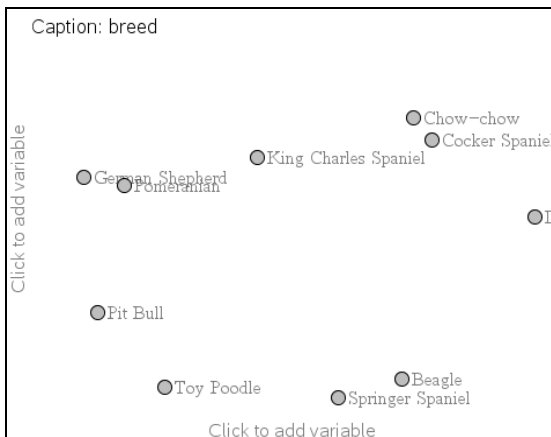
1. In Lists & Spreadsheet, create a spreadsheet that includes at least one column of string values that can be used as categories for data.

	A	B	C	D	E	F
	breed					
1	Chow-ch..					
2	German ...					
3	Toy Poo...					
4	"Toy Poodle"					
5	Beagle					
6	Cocker S..					
7	Doberma..					
8	Pit Bull					
9	Pomeran...					
10	Springer...					
11	King Cha...					
	"Toy Poodle"					

Note: To type a string in Lists & Spreadsheet, enclose the characters in quotes.

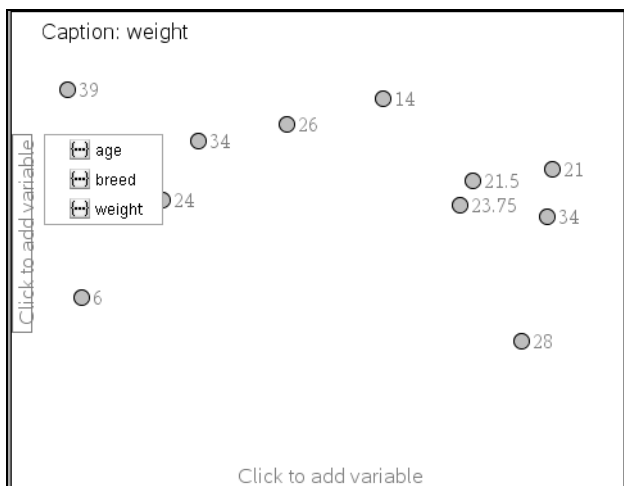
2. Add a Data & Statistics page to the problem.

Note: You can also use the Lists & Spreadsheet Quick Graph tool to automatically add a Data & Statistics page and plot selected columns.

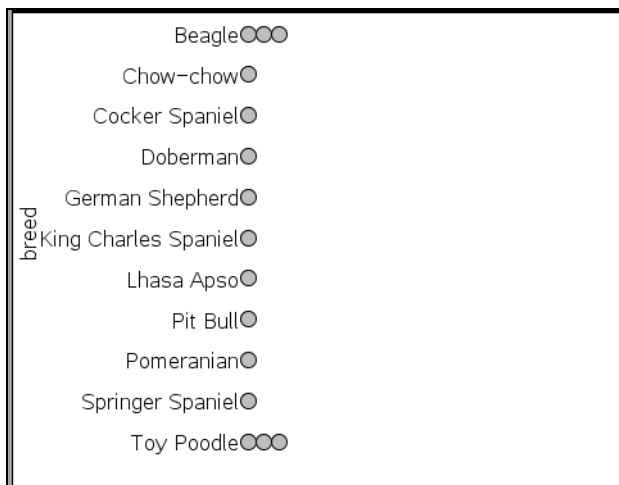


By default, the work area for the new page includes a caption and related data points. Data & Statistics selects a variable from a Lists & Spreadsheet page in the problem to use for the default caption. You can click the caption and click **None** to remove it, or click the add variable region of the caption to change the variable used.

3. Move near the middle of horizontal or vertical axis and click the add variable region to display the available variables.



4. Click the name of the variable that contains the categories you want to use for sorting data.



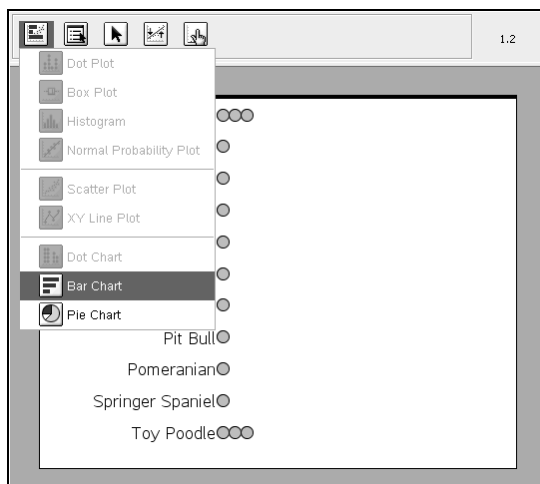
A dot chart plots in the work area. Data & Statistics labels the axis with the variable name and shows a dot for each instance of each category, which in this case is a breed of dog.

Bar charts

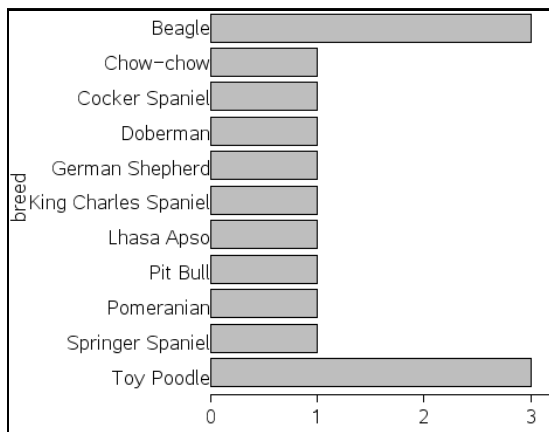
Like dot charts, bar charts summarize data that is categorical. The height of a bar represents the number of cases in the category.

Creating a bar chart

1. Create a dot chart on the work area.
2. Select **Bar Chart** on the **Plot Types** menu.

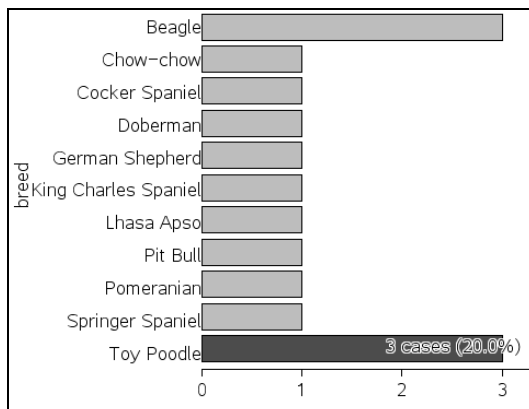


The dot chart changes to a bar representation of the data.



The height of each bar represents the number of cases in the category.

3. Click and hold a bar to see a category summary (the number of cases and percentage among all categories).



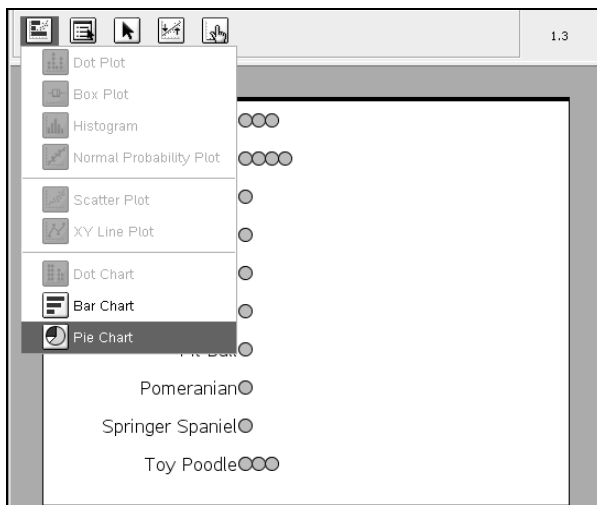
Clicking and holding the bar for the Toy Poodle category displays the category summary. The summary shows that there are three cases for Toy Poodle and that these cases make up 20% of all cases for the variable, **breed**.

Pie charts

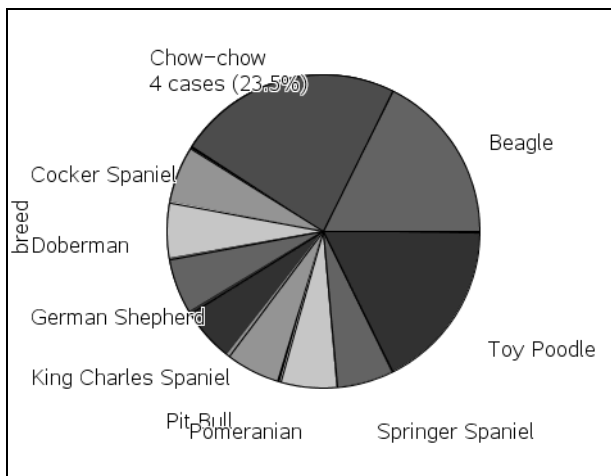
A pie chart represents categorical data in a circular layout and uses an appropriately proportioned segment for each category.

Creating a pie chart

1. Create a dot chart on the work area.
2. Select **Pie Chart** on the **Plot Types** menu.



The dots in the dot plot move toward locations according to category and are replaced with the shaded segments of the pie chart. Variations in shading distinguish the different categories of data.



- Click and hold a segment to see the summary for the category. The summary displays the number of cases for the category and the percentage among all cases.


Plotting data using a Categorical split




You can plot data using a categorical split to see values from a list plotted on an axis and sorted based on subsets of data represented on the second axis.

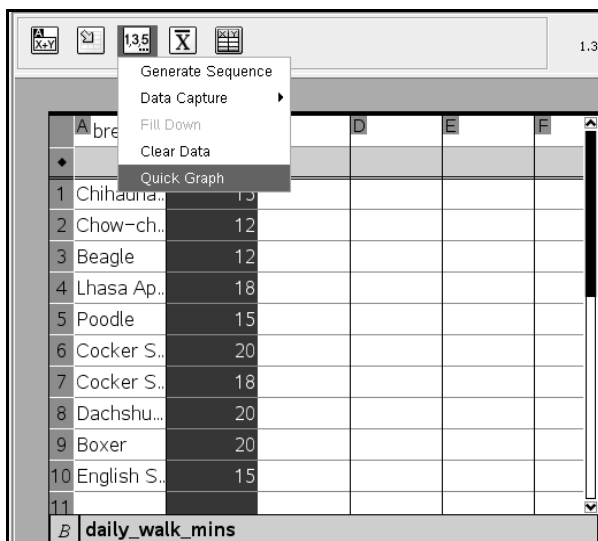
1. Open a problem that includes a Lists & Spreadsheet page, or create data to be plotted in Lists & Spreadsheet.

In the example below, a spreadsheet shows a dog's breed and walk duration in the columns **breed** and **daily_walk_mins**.

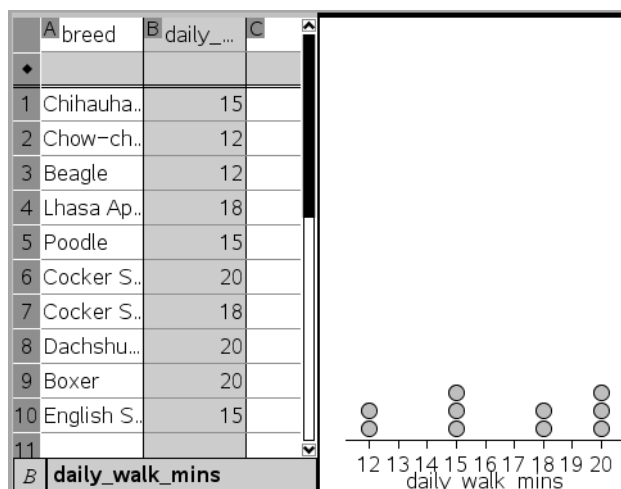
	A breed	B daily_...	C	D	E	F
◆	daily_walk_mins					
1	Chihauha..	15				
2	Chow-ch..	12				
3	Beagle	10				
4	Lhasa Ap..	18				
5	Poodle	15				
6	Cocker S..	20				
7	Cocker S..	18				
8	Dachshu...	20				
9	Boxer	20				
10	English S..	15				
11						
B	daily_walk_mins					

2. Click the column letter (B) to highlight the **daily_walk_mins** column.
3. From the Lists & Spreadsheet **Data** menu , select the **Quick Graph** tool.

Press   .

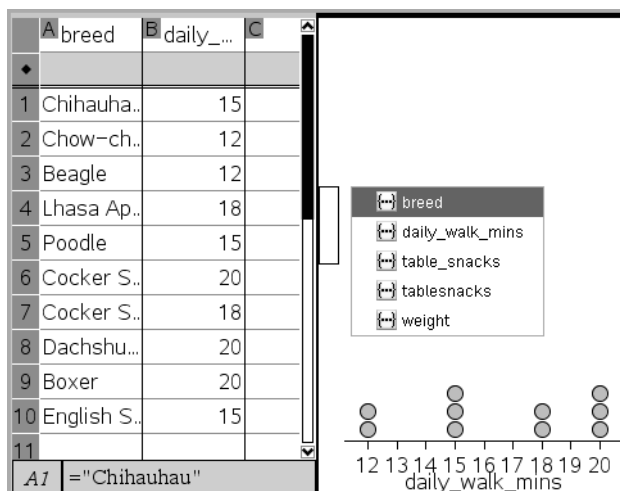


The Quick Graph tool adds a Data & Statistics page. Data & Statistics plots the selected column on the horizontal axis and uses **daily_walk_mins** (the column name) as the label for the horizontal axis.



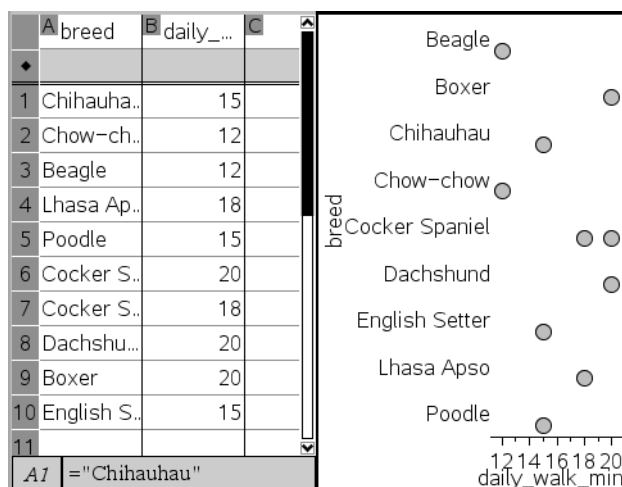
- To sort the data using a categorical value, move near the middle of the vertical axis and click .

The list of available variables displays near the axis.



5. On the list of variables, click the name of the categorical variable to use for the sort.

In this example, **breed** is the category for sorting. Data & Statistics labels the vertical axis with the breeds included in the list.



The dots in the plot move into position on the vertical axes. The values in the variable **daily_walk_mins** are sorted by category (breed). The dots are positioned according to the label for the breed on the vertical axis. You can then change plot types to see a split box plot or histogram.

Exploring data

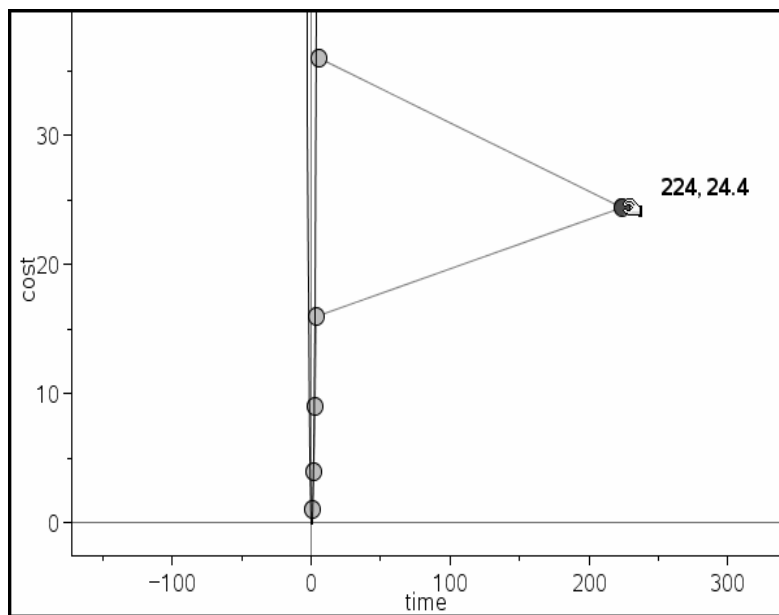
You can manipulate and explore plotted data in the following ways:

- Select and move points or data bins
- Change the type of plot
- Rescale the graph
- Add a movable line
- Show regression lines
- Show residual squares
- Show a residual plot

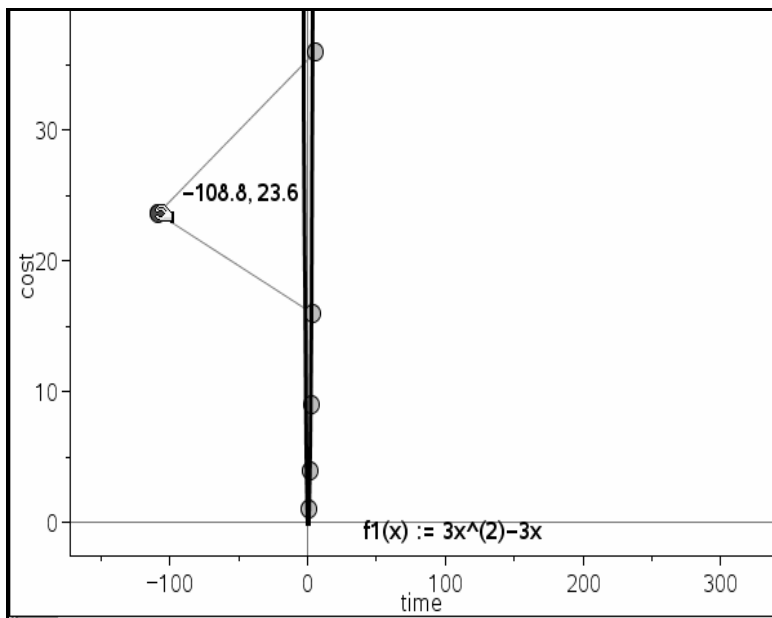
Moving points or bins of data

1. Click on and hold the desired point or bin.

The cursor changes to .



2. Drag the point or bar to the new location and release it.




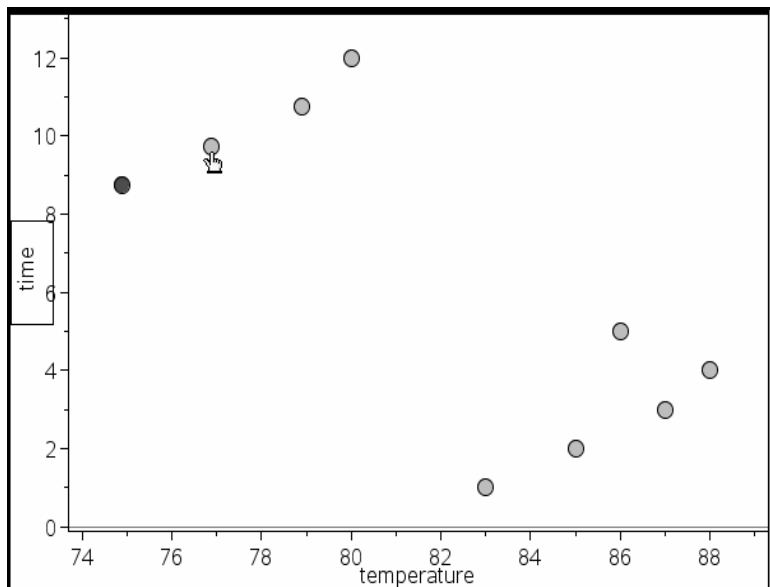
If you are working with data from Lists & Spreadsheet, the data that corresponds to the original point or bar automatically updates in the original column(s) in Lists & Spreadsheet as you move the point.

	A time	B cost	C	D	E	F	G	H	I
•									
1	1	1							
2	2	4							
3	3	9							
4	4	16							
5	-108.831	23.5727							
6	6	36							
7									
8									
9									
10									
11									
12									
B1 1									

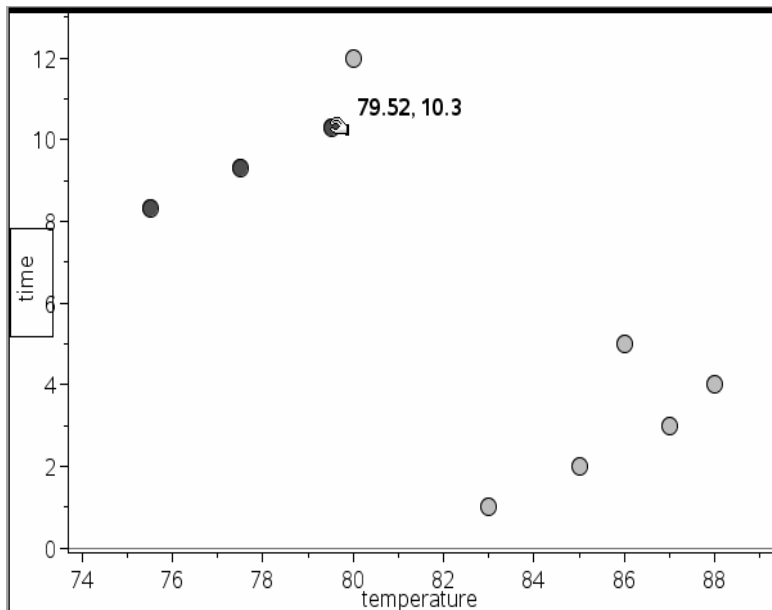
You can also move points or bins by changing the numbers in Lists & Spreadsheet or Calculator. Data will update in all of the representations.

Selecting multiple points

1. Position the cursor over each point you want to select. The cursor changes to .
2. Click to add the point to the selection.

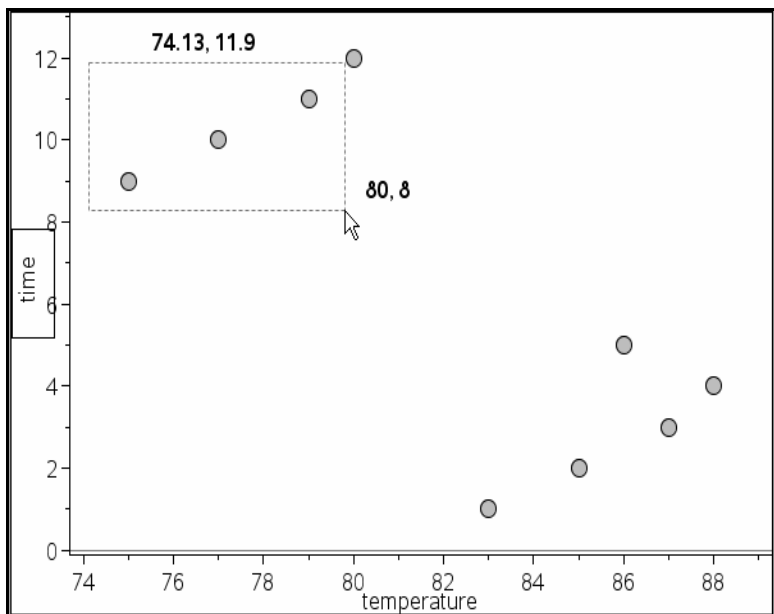


- Once you have selected the desired points, hover over one of the points. The cursor changes to $\{\}$. To move the points around in the work area, click and hold a point, or press **Ctrl** and click to grab a point.



Selecting a range of points

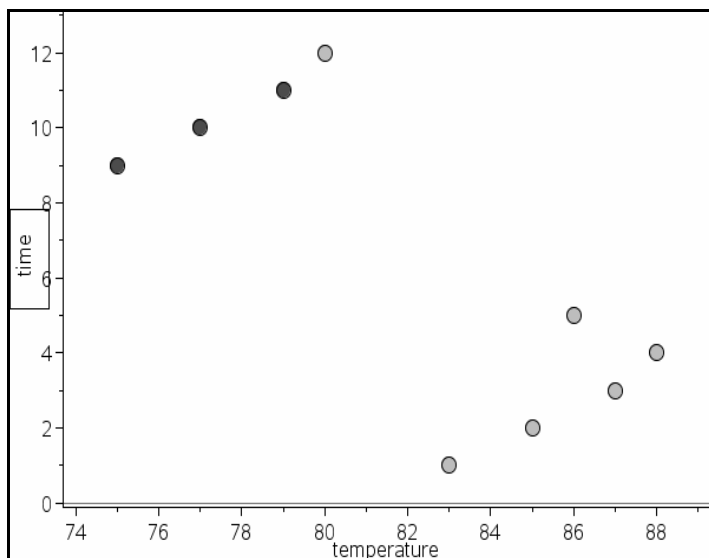
1. Select a range of points with a click-and-drag movement to place the bounding outline (dotted line box) around the points you want to select.
2. To move the selected points, click any point in the selection.



When you release the mouse button, the points are selected.

- Once you have selected the desired points, click one of the points.



The cursor changes to $\{\}$, and you can move the group of points in the work area.






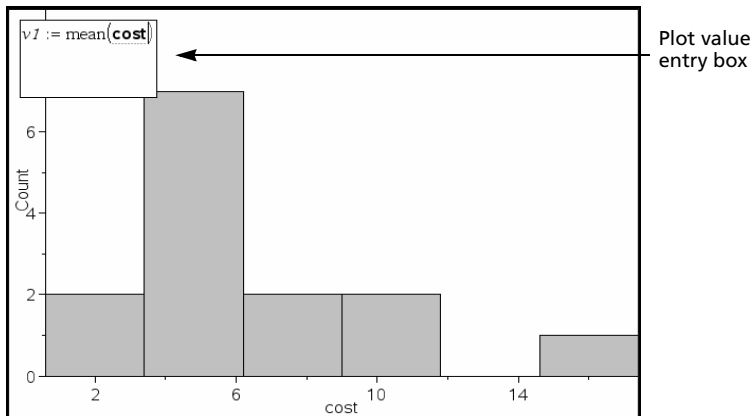
Note: When a list is defined in Lists & Spreadsheet as a formula, the movement of points is restricted to only points that satisfy that formula.

Plotting a value

You can plot a value on an existing plot. It displays as a vertical line in the work area.

1. From the **Analyze** menu , select **Plot Value** . A data entry box opens in the work area.

Press   .

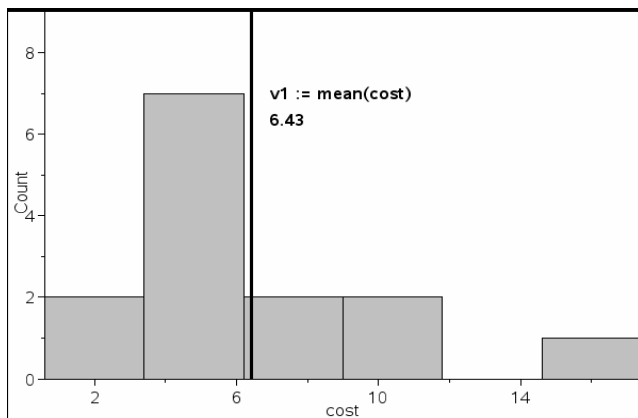


2. Type the value you want to plot, and press .

In this example, the value is $v1 := \text{mean}(\text{cost})$.

3. The line is drawn at that value, perpendicular to the axis. Click on the line to display the value.


Note: Double-click the value line to edit it in the work area.







Plot value line with value displayed

You can use Plot value for a single number or any expression that evaluates to a number. If the value is dependent on the data, like **mean**, when you drag a point or make changes in Lists & Spreadsheet, the line updates to reflect the change, allowing for investigation of the influence of points on the calculation.

Removing a plotted value

- ▶ To remove a plotted value from the work area, click on the line to select it, and then select **Remove Plotted Value**  from the

Actions menu .

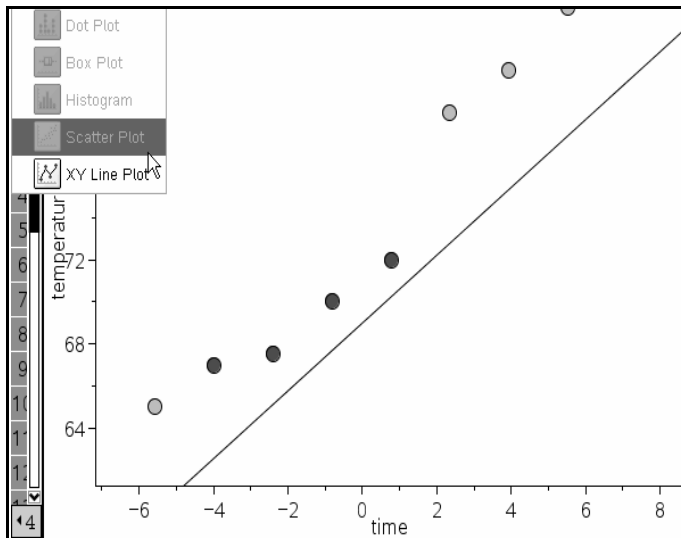
Press   .

Changing plot type

You can change the plot type, to view different representations of data.

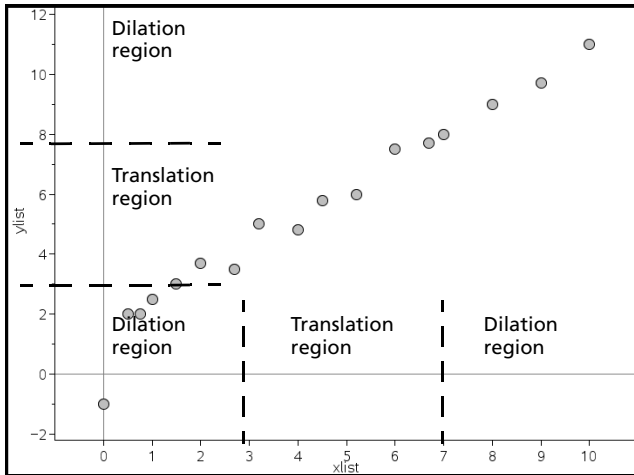
- ▶ Click the **Plot Type** menu  and select the new plot type. The data representation changes to the new plot format.

Note: Options are unavailable on the menu if your data cannot be represented by the plot type. For example, if a scatter plot is displayed in the work area, you cannot create a box plot without first removing the Y component of the plot.



Rescaling a graph

You can change the scale of the axes for translation and dilation:

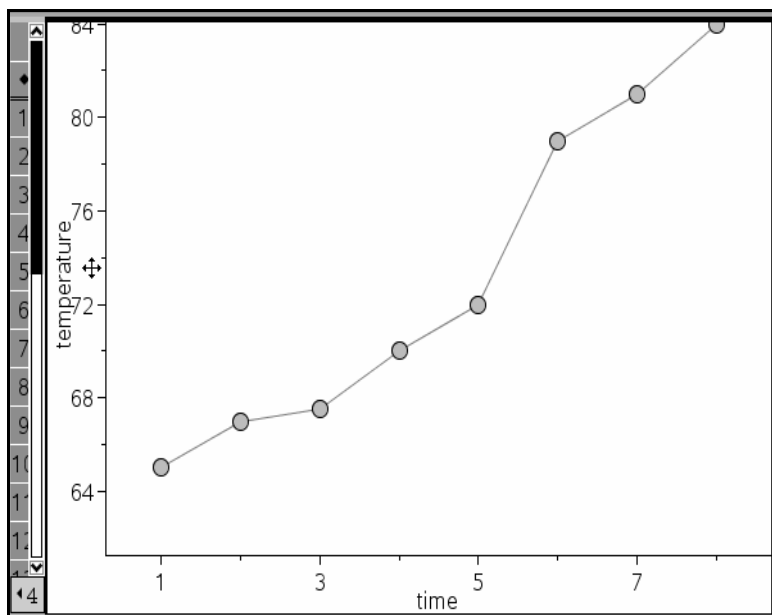



The cursor changes to indicate whether translation (\oplus) or dilation (\oplus) is available in zones on the axes.

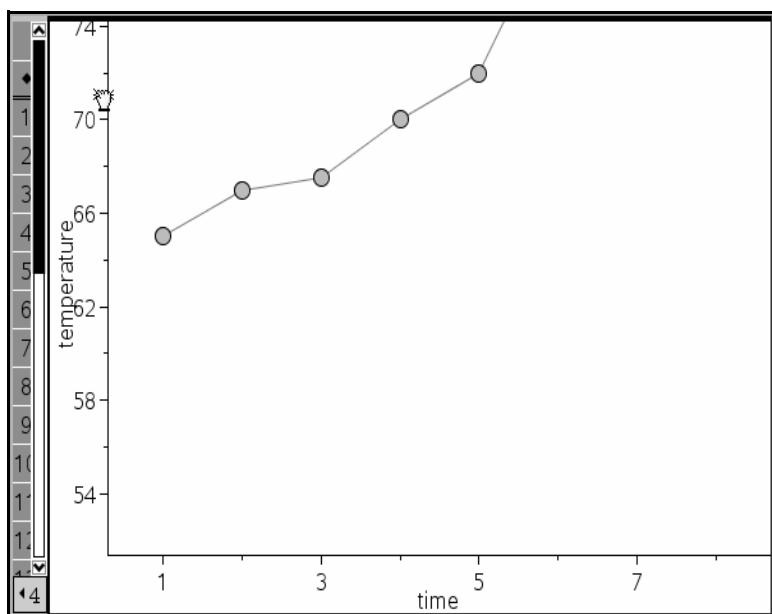
Translation

A translation slides a set of axes a fixed distance in a given direction. The original axes have the same shape and size.

1. Position the cursor over a tic mark or label in the middle third of the axis. The cursor changes to \oplus .



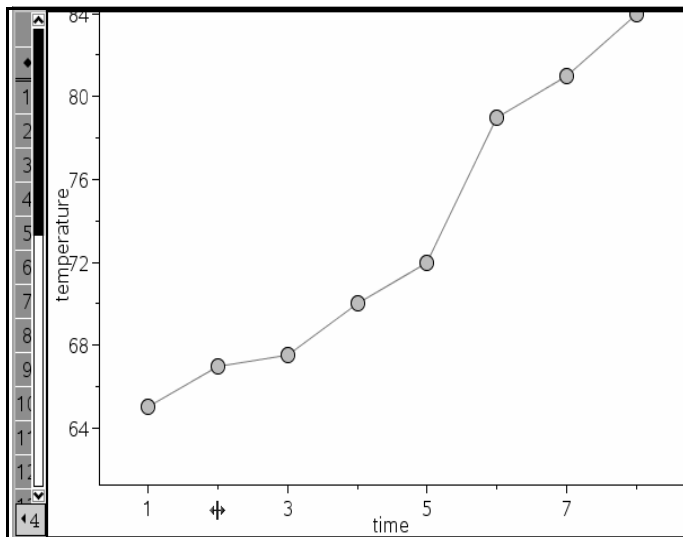
- Click to grab. The cursor changes to . Drag the cursor to the desired position and release.



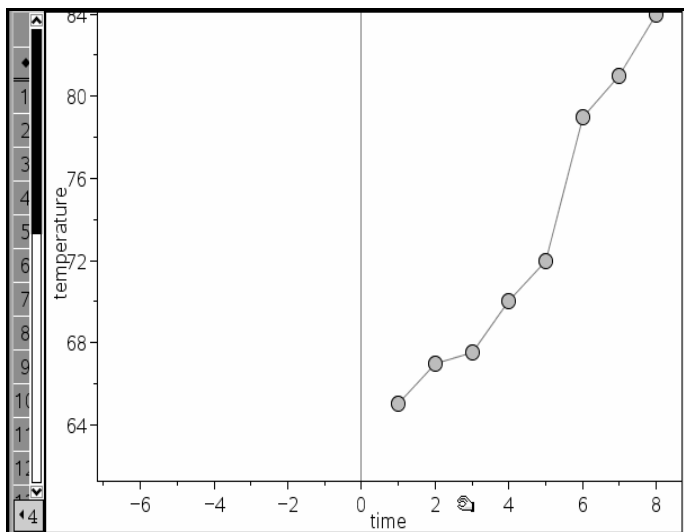
Dilation

Dilation retains the shape of the axes, but enlarges or reduces the size.

1. Position the cursor over a tic mark or label near the ends of the axis. The cursor changes to ∇ on the vertical axis or \blacktriangleright on the horizontal axis.






2. Click to grab. The cursor changes to Ⓢ . Drag the cursor to the desired position and release.



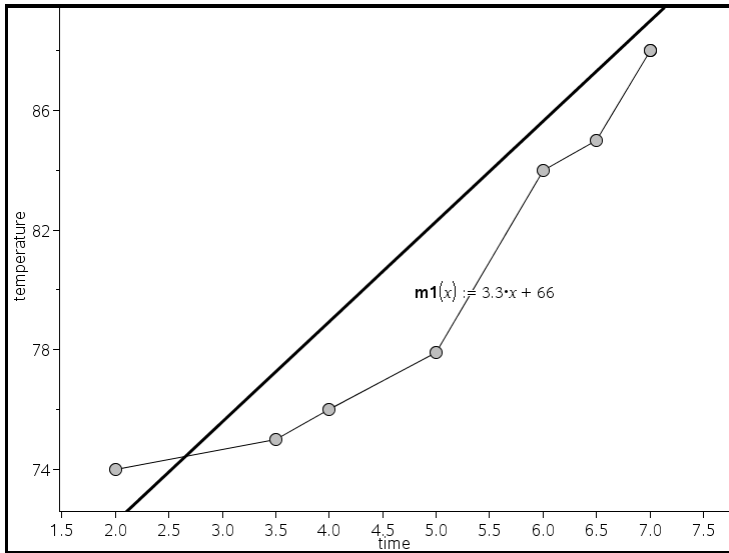
Adding a movable line

You can add a movable line to a plot. Moving and rotating the line on the work area changes the function that describes it.

- ▶ Select **Add Movable Line**  from the **Analyze** menu .


Press   .

The movable line displays and is labeled with a function that describes it. For this example, Data & Statistics stores the expression for the movable line in the variable **m1**.

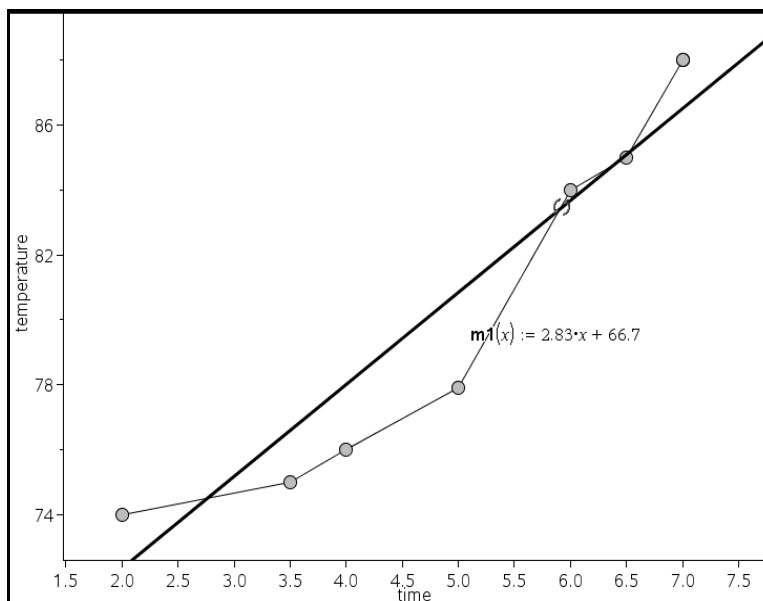


Rotating a movable line

1. Click and grab on either end of the line.

The cursor changes to .

2. Drag to rotate and change the slope of the line.



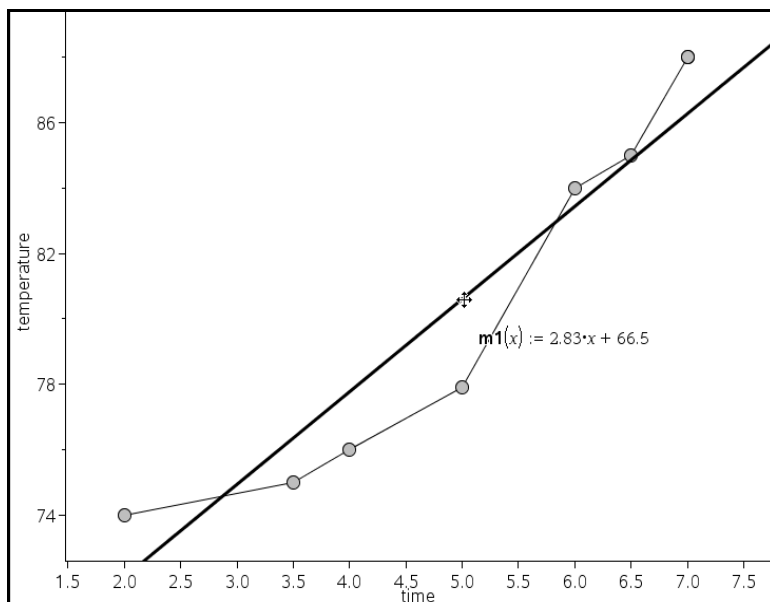
The function $m1(x)$ is updated for the changes in the position of the movable line.

Changing the intercept

1. Click in the middle of the movable line.

The cursor changes to \oplus .

2. Drag to change the intercept.






The number at the end of the equation changes to show the change in the intercept.

Note: The movable line is stored as a function that can be used for prediction in the Calculator application.

Locking the intercept at zero

You can lock the intercept of the movable line at zero.

- ▶ Select **Lock Intercept at Zero**  from the **Analyze** menu .




Press   .

Note: This tool is only available when movable line is present in the work area.

Unlocking the intercept


To unlock the intercept:




- ▶ Select **Unlock Movable Line Intercept**  from the **Analyze** menu .

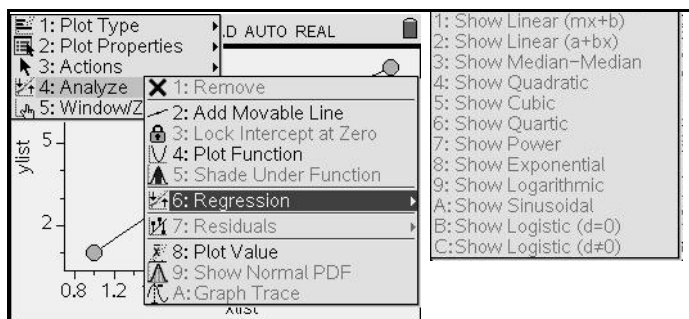
Press   .

Showing regression lines

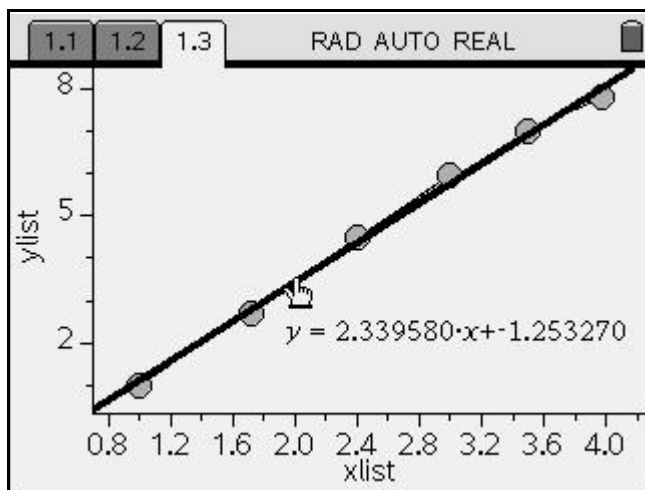
You can show a line of regression when you have a scatter plot or an X-Y line plot on the work area. Studying the line of regression can help you understand the relationship between two variables.

1. With a scatter plot or X-Y line plot of two variables on the work area, select **Regression** from the **Analyze** menu .

Press    and the number of the regression.



2. Click to select the type of regression line to show. For example, choose **Show Linear (mx+b)** to plot a linear regression line as shown in the following example.






When the line of regression is selected, the expression for the line displays.

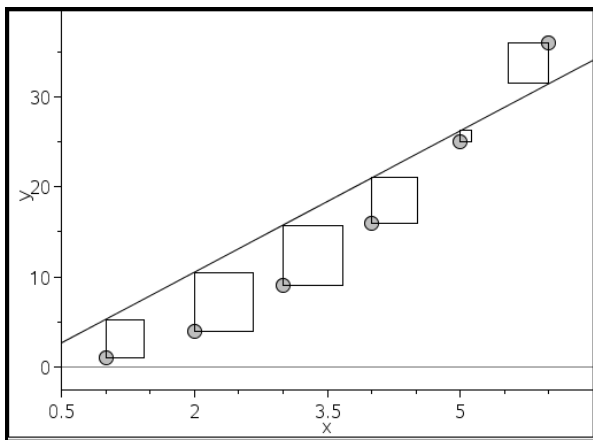
Showing residual squares

You can display residual squares on a plot. Residual squares can help you assess the appropriateness of the model for your data.

- ▶ Select **Show Residual Squares**  from the **Analyze** menu .

Press   .





Note: This tool is only available when a regression or movable line is present in the work area.

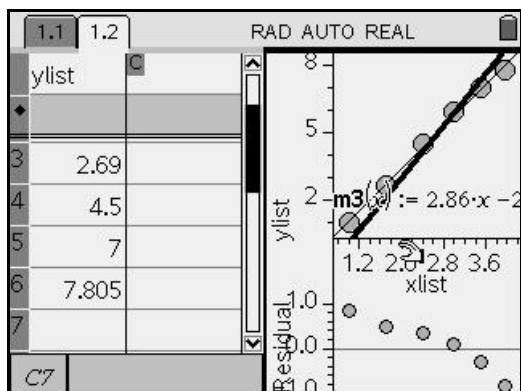


The sum of squares is updated as the line or data changes.

Showing a residual plot

You can show a residual plot to determine how well a line fits data. The work area must include a scatter plot and one or more movable lines, regressions, or plotted functions for **Show Residual Plot** to be available.

- ▶ With a scatter plot, line of regression, and/or movable line in the work area, press    .



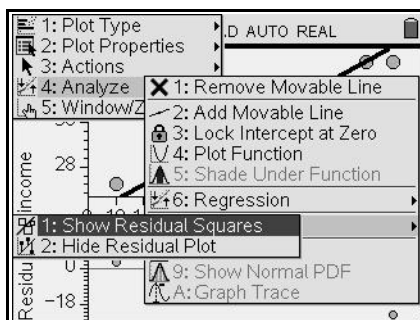
Notes:

- With multiple regressions or functions and movable lines plotted, you can select each in turn to show its residual plot.
- Click and hold a dot on the residual plot to see the residual.
- The residual plot for the selected regression or function displays in the work area.
- For consistency in comparing sets of data, residual plots do not rescale when you move from one function or regression to another.
- Select a function or regression before a showing residual plot. If no function or regression is selected and there are several plotted, Data & Statistics arbitrarily selects the function or regression for showing the residual plot.
- Axes can be adjusted by clicking and dragging.

Removing a residual plot




To remove a residual plot when it is no longer needed.

- ▶ With a scatter plot, line of regression, and/or movable line in the work area, press MENU 4 7 2 .







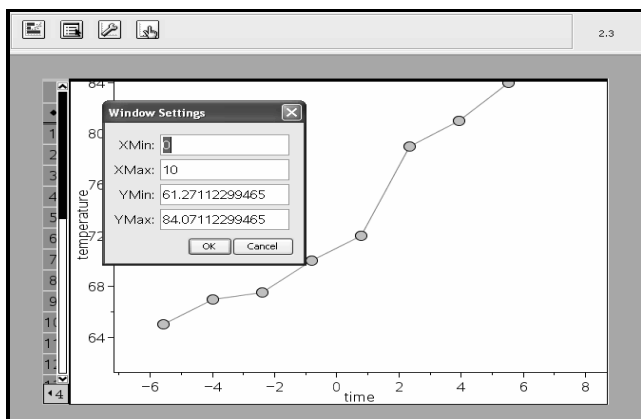
Using Window/Zoom tools

Use the Window/Zoom tools  to redefine the graph to better view points of interest. The Window/Zoom tools include:

- Window Settings: displays a **Window Settings** dialog that lets you enter the x-min, x-max, y-min, and y-max values for the axes.
- Zoom - Data : adjusts the zoom factor to display all plotted data.
- Zoom - In : lets you to define the center point of the zoom in location. The Zoom In factor is approximately 2.
- Zoom - Out : lets you define the center point of the zoom out location. The Zoom Out factor is approximately 2.

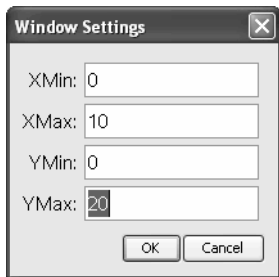
Using Window Settings

1. Click the **Window/Zoom** menu , and select **Window Settings**.
Press   .
2. The **Window Settings** dialog opens. The current values for x-min, x-max, y-min, and y-max display in the fields.

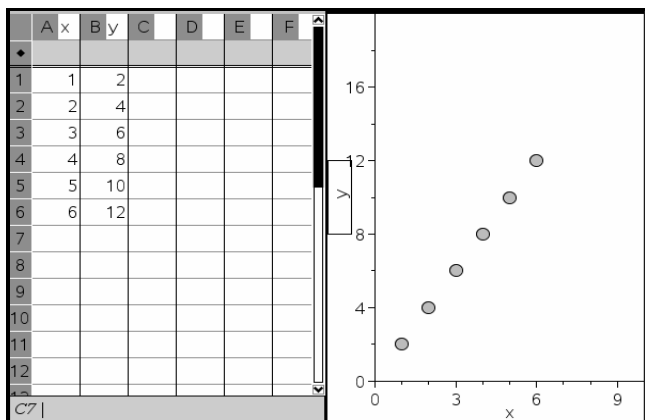


Note: Only the appropriate boxes are editable, depending on whether there are one or two axes in the work area.


3. Type the new values over the old values.





4. Select **OK** to apply the changes and redraw the plot.





Using Zoom Data

1. Click the **Window/Zoom** menu , and select **Zoom Data** .
Press **menu** **4** **1**.
2. The work area rescales to display all plotted data.

Using Zoom In



1. Click the **Window/Zoom** menu , and select **Zoom In** .
Press **menu** **4** **3**.
2. In the work area, click the center point of the area of interest. This will be the center of the zoom in action.
3. The plot redraws to focus and enlarge the portion of the plot centered about the point you selected in the previous step.

Using Zoom Out

1. Click the **Window/Zoom** menu , and select **Zoom Out** .
Press (menu) 4 4.
2. In the work area, click the center point of the area of interest. This will be the center of the zoom out action.
3. The plot redraws to display a larger portion of the plot, centered about the point you selected in the previous step.

Graphing Functions



You can graph functions by typing them in Data & Statistics, or you can graph functions defined in other applications.

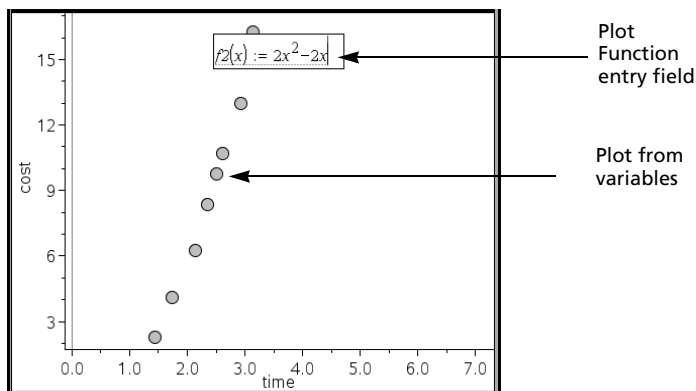
- ▶ From Data & Statistics: select the Plot Function tool  from the **Analyze** menu .
Press (menu) 3 9.

Graphing functions using the Plot Function tool

You can use the Plot Function tool to plot functions in a work area that already includes a plot on the axes. Plot Function lets you specify and graph a function for comparison to an existing plot.

To use the Plot Function tool:

1. Create or open a problem that includes variables (from Lists & Spreadsheet) that are plotted on a Data & Statistics work area. Ensure that your work area contains both a horizontal axis and a vertical axis scale.
2. From the **Analyze** menu , select the **Plot Function** tool .
Press (menu) 3 9.
3. A function entry field displays in the work area.

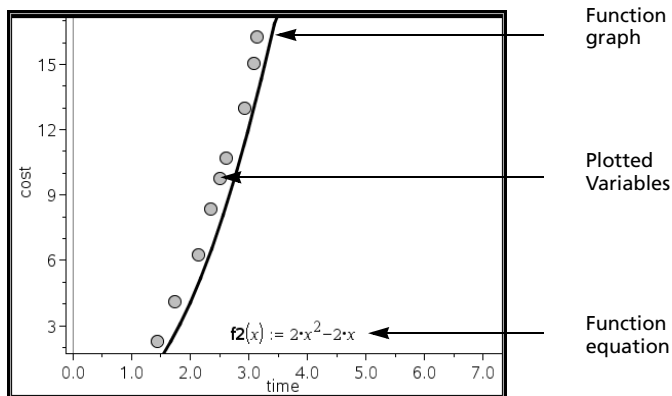


Note: You can edit the function's expression typed in the entry field. However, the function graphed in Data & Statistics cannot be manipulated or moved around the work area. To do that, use Graphs & Geometry.

4. Type the function in the entry field, and press **Enter**.

Note: You can rename the function by typing over $f_1(x)$: with another name, if you choose.



5. The function graphs in the work area and is saved as a variable for use in other applications.






Entering functions from other applications

You can enter a function that has been defined as a variable in another application, such as Lists & Spreadsheet, Graphs & Geometry or Calculator.

1. Ensure that your work area contains both a horizontal axis and a vertical axis scale.

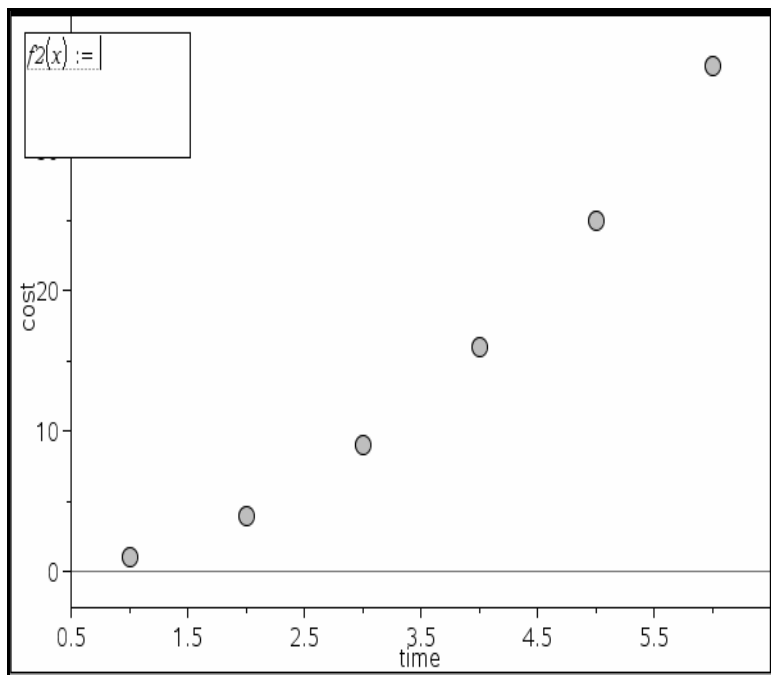
2. From the **Analyze** menu , select the **Plot Function** tool .

Press   .

A function entry field displays in the work area.

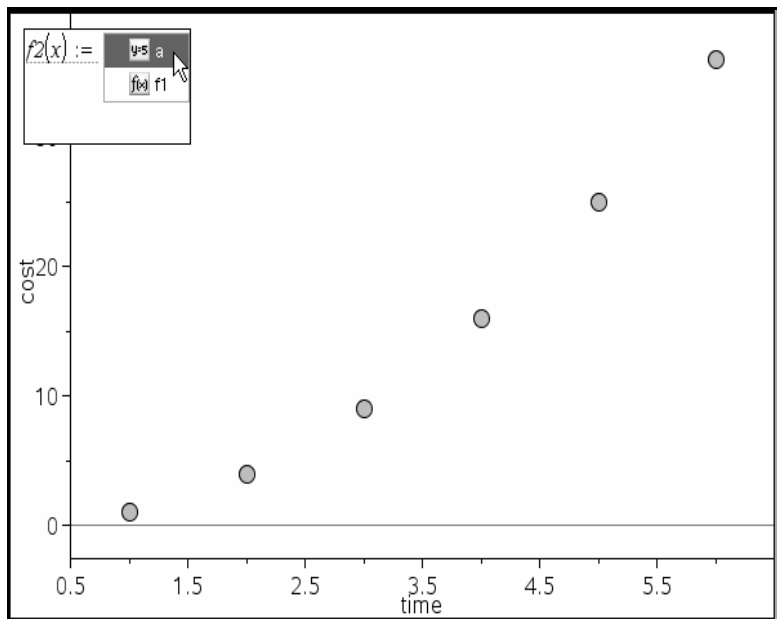
3. Click **var** on the tool bar to open the **Variables** menu.

Press .



A list of variables available in the problem displays.

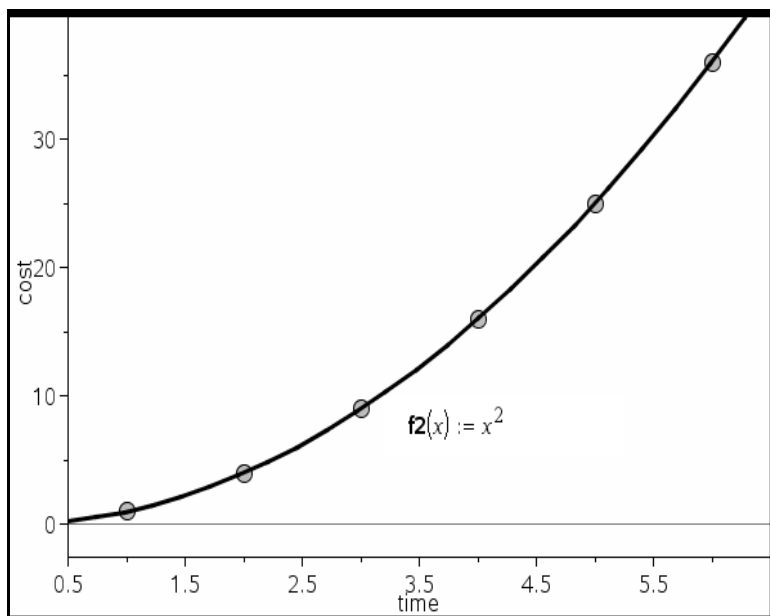
4. Click to select the variable containing the function you want to plot.



In the example below, the variable **a** contains the function $f(x)=x^2$.


5. Press **Enter**.

The function plots in the work area.



Editing a function

You can edit a function and update it on the work area.

1. You can edit a function by double-clicking the equation and then making changes as required.
2. Press  after making all changes and the updates display in the work area.

Using Data & Statistics functions in other applications

Data & Statistics functions are stored as variables, and may be used in other applications, in the same manner as any other variable. Support for all function types is included.

Note: Function numbers increment to use the next available. If you have defined $f_1(x)$ and $f_2(x)$ in Graphs & Geometry, the first function you create in Data & Statistics will be $f_3(x)$.

Using Show Normal PDF

You can approximate data plotted in the Data & Statistics work area against the normal probability density function. The tool overlays the normal probability density function using the mean and the standard deviation of the data in the histogram.

To show the normal probability density function for plotted data:

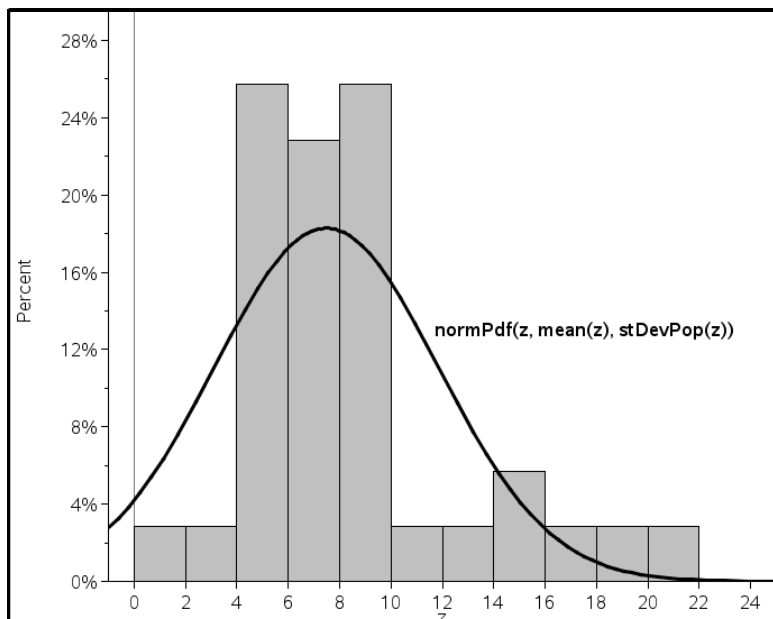
1. Select plotted data in the Data & Statistics work area and display it in a histogram format.

2. Select **Show Normal PDF** () on the **Analyze** menu ().

The normal PDF for the graph plots in the work area. The expression used to calculate the PDF displays when selected.

Select **Hide Normal PDF** on the **Analyze** menu to remove the PDF.

Note: **Show Normal PDF** is available only when histogram is the plot type.






Using Shade Under Function

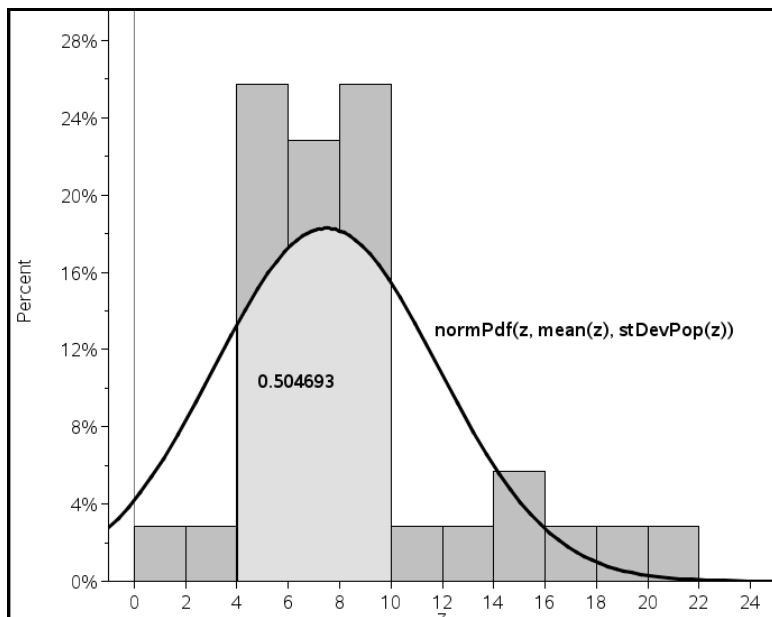
Use Shade Under Function to find the area of a selected region under a function graphed in the work area.

1. Select any function graphed in the Data & Statistics work area. For example, select a previously graphed normal PDF.

2. Select **Shade Under Function** () on the **Analyze** menu ().

Press   .

The cursor becomes a dotted vertical line and the boundary $\pm \infty$ displays when you position the mouse near the boundary on the left or right. You can click when ∞ displays to set it as a boundary.



3. Select a point on the curve and click to indicate where to start shading under the function. The direction in which you move next determines whether the region shaded is on the left, right, or center of the curve.
4. Select a point on the curve and click to indicate the end boundary of the shaded area. A region under the function is shaded based on the points you selected.

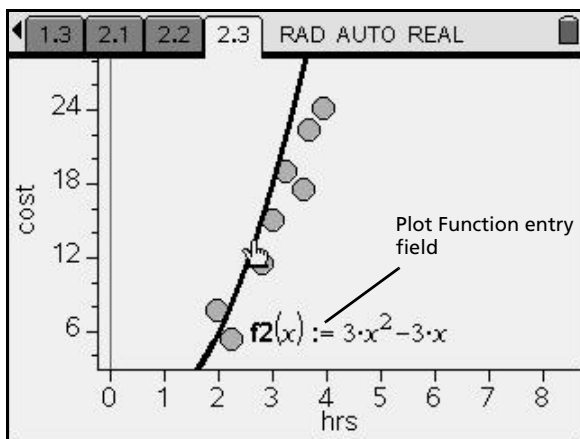
You can work with Shade Under Function in the following ways:



- Select the region to display the shaded area.
- Select **Shade Under Function** again to shade multiple areas.
- Select **Remove Shaded Region** on the context menu to remove shading.
- Use plot value to set the boundary to an exact number. When a boundary for shading is set to a plotted value, you can change the plotted value to update the shading.
- Edit a shaded region by clicking and dragging the starting or ending boundary.




Using Graph Trace

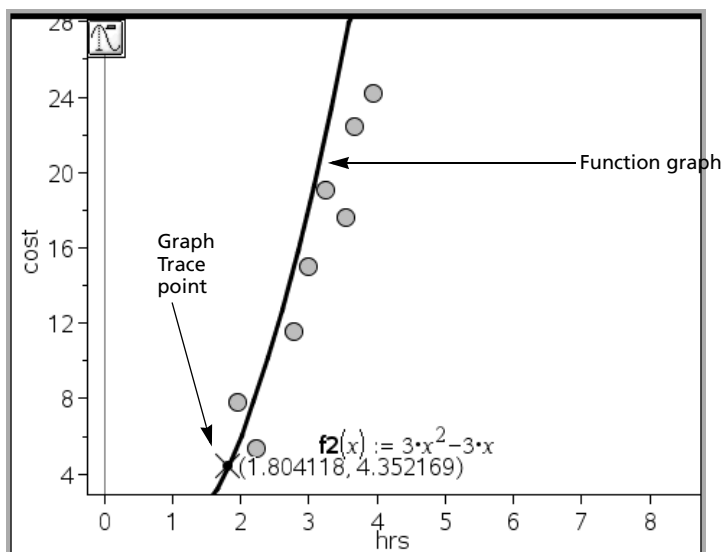
Graph Trace lets you move from one point on a graph to another in order to analyze variations in the data. Use Graph Trace mode to explore the data for a Plot Function, Show Normal PDF, or a distribution curve (created in the Lists & Spreadsheet application).

1. On the **Analyze** menu , select **Plot Function**  to plot a graph in the work area.



2. From the **Analyze** menu , select **Graph Trace**  to change to trace mode.

Press   .



The Graph Trace point displays on the graph.

3. Graph trace enables the following operation:



- Press $\blacktriangleleft \blacktriangleright$ to move along the function's graph. The coordinates of each point display during the trace.
- Press $\blacktriangle \blacktriangledown$ to move from one function graph to another or to a scatter plot. The point's coordinates update to reflect the new location of the trace. The trace cursor is positioned on the point of the new graph or plot with the closest x value to the last point identified on the previously traced function or graph.
- View the points of interest ("Z" for zero, "M" for local maximum, and "m" for local minimum) that display as you trace a function's graph.
- Type a number and press Z Enter to move the trace cursor to that x value on the function's graph.
- With a point selected, press **Enter** to save it.

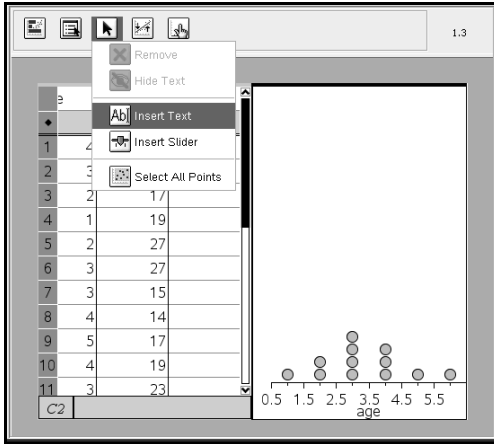
4. Use the **Esc** key to exit trace mode. Choosing another menu item also exits the trace mode.

Using other Data & Statistics tools

Inserting text

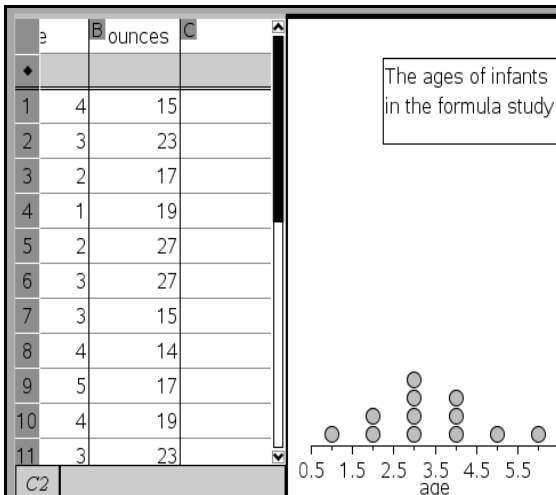
The Insert Text tool lets you type text that describes information related to a plot in the work area.

1. From the **Actions** tool menu , select **Insert Text** .



A text entry field displays.

2. Type notes or descriptions in the text entry field.



You can customize the text in the following ways:

- Press ⌘ to insert a new line.
- Click outside of the text entry field to end editing.
- Move the cursor over the edges of the text box to drag the borders and change the width or height.
- Click and grab the text box to move it near objects that relate to the text.

Hiding text

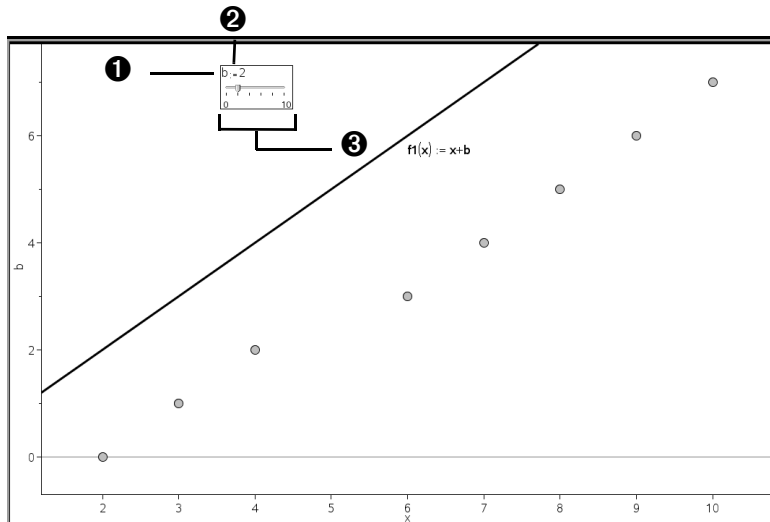
To hide text on the work area:

- ▶ Select the text and choose **Hide Text**  on the **Actions**  menu.

Using Sliders

Sliders let you easily change the value of a numeric value in the Graphs & Geometry and Data & Statistics applications. Inserting a slider lets you represent multiple variable values in a continuous range. In the following example, the slider represents the numeric variable, **b** in the graphed function.

- ▶ To insert a slider, select **Insert Slider** on the **Actions** menu. The slider displays on the work area.



- ❶ Variable statement that includes the name of a numeric variable in an entry field, the assignment operator ":=", and the value set for the numeric variable in a second entry field
- ❷ Slider that you can move to values on the scale when the control is active
- ❸ Track with labels for the minimum and maximum values on the scale and scale tic marks between the end values

Basic slider operation

When the slider is inserted, you can change the name by typing the name of the variable you want to use over the default, *v1*. To accept the default variable, press **Enter**.

You can move the slider to set the variable to a value, or type a number in the text box after the equal sign. Press **Esc** or click another part of the work area to cancel selection of a slider.

You can use a slider in the following ways:

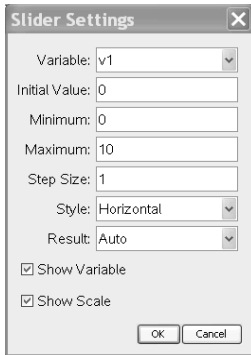
- Grab the slider and drag it to set the variable to any value within its range.
- Click a point near the slider track to grab the entire control for operations such as copying, moving, and deleting.
- Drag the track ends to change the length of the slider scale.
- Click the text box for the slider variable name and type the name of the numeric variable to use. You can use an existing numeric variable or use the slider to create a new one.

Context menu and slider settings

To change the settings for a slider, access the slider context menu:



Select **Settings** to display the **Slider Settings** dialog:



Specify the values to use for the slider:


- | | |
|---------------|---|
| Variable | Sets the name of the numeric variable used with the slider. Type the value in the field or click the drop-down arrow to select a value from the list. |
| Initial value | Sets the starting value of the variable. |
| Minimum | Sets the lowest value in the range of values used with the slider. This value displays at the left end of the scale. |
| Maximum | Sets the highest value in the range of values used with the slider. This value displays at the right end of the scale. |
| Step Size | Sets the size of the increment between values. When a slider is active, you can use the arrow keys to move the slider up or down the scale by this amount. |
| Style | Lets you choose how the slider is displayed in the work area. Choose horizontal for a left-to-right scale, or choose vertical for a top-to-bottom scale. To display a slider that includes the variable name, current value, and direction arrows only, choose minimized. |
| Result | Lets you choose the format for the displayed value of a slider. Choose Auto to let slider operate in the default format, or choose from eight floating point formats. |
| Show variable | Shows or hides the variable. |
| Show scale | Shows or hides the scale on the slider track. |

Animating a slider

From the slider context menu, click **Animate** to step through the variable range automatically. To stop the animation, click **Stop Animate**.

Minimizing a slider

From the slider context menu, click **Minimize** to show a smaller display that includes the variable name, the current value of the variable, and up and down arrows.

Minimized $v1 := 5.38$ 

Using Statistical Tools

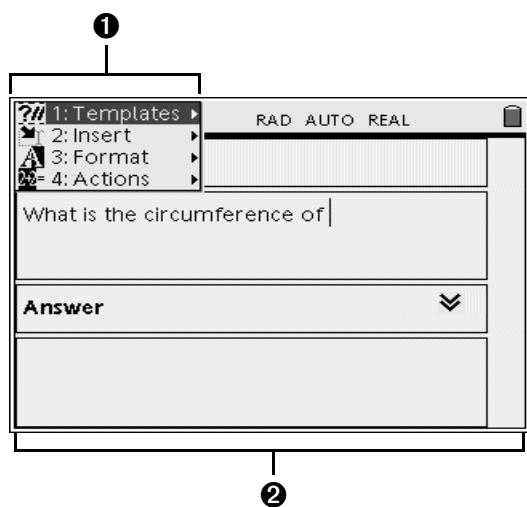
Once you have plotted one or more variables in Data & Statistics, you can manipulate and explore the data using calculations, data fitting techniques, hypothesis testing tools, and distributions. These functions are available in the Lists & Spreadsheet application. Refer to that chapter for further information.


Using Notes

Getting started with the Notes application

The Notes application provides text editing functions that allow you to create and share documents with others using the TI-Nspire™ handheld and computer software.













You can use the Notes application as a tool to create study notes to reinforce your understanding of classroom concepts and to review for exams. The Notes application allows you to assign different roles to individuals using your document, so that any edits appear in a different text format, making it easy to edit collaboratively.



- 1 Notes tool menu – This menu is available anytime you are in the Notes work area. Press  to display the menu.
- 2 Notes work area -- The area where you enter and format text.

The Notes tool menu

The Notes tool menu lets you select a Notes template, format text, and evaluate expressions. The table below describes the menu items and their functions.

Menu Name	Menu Option	Function
 Templates		
	 Q&A	Creates a template to enter question and answer text.
	 Proof	Creates a template to enter statement and reason text.
	 Default	Lets you enter freeform text.
 Insert		
	 Math Expression Box	Lets you insert a math expression.
	 Shape	Marks the selected text as an angle, triangle, circle, line, segment, ray, or vector.
	 Comment	Lets you enter text that is italicized and prefaced with Teacher or Reviewer .
 Format		
	 Bold	Toggles the selected text between bold and not bold, and removes all other formatting.
	 Italic	Toggles the selected text between italic and not italic, and removes all other formatting.
	 Underline	Toggles the selected text between underlined and not underlined, and removes all other formatting.



Subscript

Toggles the selected text between subscripted and not subscripted, and removes all other formatting.



Superscript

Toggles the selected text between superscripted and not superscripted, and removes all other formatting.



Actions



Evaluate selection

Replaces the selected part of the expression with the result.



Evaluate

Replaces the current math expression with the result.



Show or Hide Answer

Shows or hides the answer in a Q&A template.

Before you begin

- ▶ Turn on the handheld, and add a Notes application to a document.

The Notes work area

The Notes work area is where you enter and format text.

Question
What is the circumference of
Answer ⌵




Notes templates

The Notes application provides templates for creating three types of notes:


- **Q&A** for questions and answers, with the answer shown or hidden
- **Proof** for an outline structure containing statements and reasons
- **Default** for open-formatted text entry


Applying a Notes template

1. While in the Notes work area, press  to display the Notes menu.
2. On the **Templates** menu, select the specific template to apply.

Using the Q&A Template


Use the Q&A template to create questions and answers. You have the option to show or hide the answer, so you can create questions for review and hide the answers. When you use the document as a study aid, you can verify that your answers are correct.

Press  to move the text cursor between the **Question** and **Answer** areas of the template.

Question
What is the circumference of
Answer 

Using the Proof Template


The proof template provides an outline structure for statements and corresponding reasons.

Press  to move the text cursor between the **Statements** and **Reasons** areas of the template.


Statements	Reasons

Inserting comments

You can insert Teacher or Reviewer comments into a Notes application. Comments are easily identifiable and easy to distinguish from the original text.

1. While in the Notes work area, press  to display the Notes menu.
2. On the **Insert** menu, select **Comment**, and then select **Teacher** or **Reviewer**.
3. Enter your text.



Text that you enter appears in italics.

Question
What is the atomic weight of Hydrogen? [Teacher: <i>This is a good question.</i>]
Answer 


Formatting Notes text

Use the formatting tools on the Text options menu to specify bold, italic, underlined, subscript, or superscript text.

Selecting text

1. If you are using the Q&A or Proof template, press  to place the cursor in the area containing the text.
2. Use the NavPad to place the cursor at the start or end of the text to be selected.
3. Hold down , and use the NavPad to select the text.

Applying a text format

1. Select the text in the Notes work area.
2. Press  to display the Notes menu.
3. On the **Format** menu, select the name of the format to apply.

Formatting examples:

This line has a **bold** word.

The last word is underlined.

Here is an *italic* example.


This line contains a _{sub}script.


This line contains a ^{super}script.

Note: You can restore the text to normal by reapplying the same format.

Inserting geometric shape symbols

You can use geometric shape symbols to designate selected text as geometric objects, such as an angle, circle, or line segment.


1. Position the cursor where you want to insert a shape symbol.
2. Press  to display the Notes menu.
3. On the **Insert** menu, select **Shapes**, and then select the shape to apply.

Question
What is the area of $\triangle ABC$? What is the circumference of $\odot C$? What is the length of \overleftrightarrow{AB} ?
Answer 

Entering and evaluating math expressions


You can include math expressions in Notes text, using the same tools as in other TI-Nspire™ applications. You can also evaluate an expression and display the result.

Entering an expression

1. In the Notes work area, place the cursor where you want the expression.
2. Press  to display the Notes menu.
3. On the **Insert** menu, select **Math Expression Box**.
4. Type the expression. You can use the Catalog, if necessary, to insert a function, command, symbol, or expression template.


Evaluating an expression

Note: The result of the expression will replace the expression. If you need both the expression and its result, make a copy of the expression and then evaluate the copy.

1. Place the cursor anywhere in the math expression box.
2. Press  to display the Notes menu.
3. On the **Actions** menu, select **Evaluate**.
The result replaces the expression.

Evaluating part of an expression

Note: The result will replace the selected part of the expression. If you need both the sub-expression and its result, make a copy and then evaluate the copy.

1. Select the part to evaluate, using the earlier instructions under "Selecting text."
2. Press  to display the Notes menu.
3. On the **Actions** menu, select **Evaluate Selection**.
The result replaces the selected part only.





Using Question

TI-Nspire™ lets you open documents that contain question items and answer these questions. You can use any of the keyboard shortcuts that you can use in TI-Nspire™.

When you open this type of document, you will see the Question toolbar.

Understanding the Question toolbar


When you open documents containing questions, the Question toolbar displays, with four tools available:

Tool name	Tool function
 Clear Answers	Lets you clear the answers in the current question or in the document.
 Check Answer	If your document is in Self-Check mode, click here to view the correct answer. You cannot check answers to Exam-type questions.
 Insert	Lets you insert an expression box in your answer.
 Format	Click on this tool to format the selected text in your answer as subscript or superscript.

Navigating in the Question application

- Use the Tab key to move between fields.
- Use the arrow keys to move the cursor within the question or answer text area.

Answering questions

- In open-response questions, use any combination of text and math expressions. You can use any keys and any characters.
- In multiple-choice questions, go to the answer you want and click  **Enter** or the space bar.

Answering single-answer questions

Questions with a single correct answer use radio buttons. If you see radio (round) buttons, you can select only one answer.

- ▶ Go to the correct answer and select it. To change your answer, just move to that answer and select it. Your first choice will be de-selected.

In a group $(ab)^{-1}=a^{-1}b^{-1}$.

True

False

Answering questions with multiple answers

If you see checkboxes in the answer area, you can select more than one answer. If the question asks you to "Select all that apply," for example, you might select more than one answer.

Click on the checkbox next to each correct answer. To de-select an item, go back to that answer and use the same process as selecting.

If the last question is false, which is correct? (Select all that apply.)

$(ab)^{-1}=a^{-1}b^{-1}$

$(ab)^{-1}=b^{-1}a^{-1}$

None of the above.

Working with TI-Nspire™ libraries

What is a library?

A library is a TI-Nspire™ document that contains a collection of variables, functions, and/or programs that have been defined as library objects.

Unlike ordinary variables, functions, and programs, which can be used only within a single problem (the problem in which they are defined), library objects are accessible from any document. You can even create public library objects that appear in the TI-Nspire™ Catalog.

For example, suppose you have created library document **matrix** containing public library function **diagwithtrace()** and a private library function **errmsg()**.

Function **diagwithtrace()** displays the diagonal of a square matrix and calculates the trace of the matrix. If its input is not a square matrix, the function calls **errmsg()**, which should then return an appropriate error string.

```
Define LibPub diagwithtrace(m)=  
Func  
© diagwithtrace(mat): diagonal with trace  
  If rowDim(m)≠colDim(m) Then  
    Return errmsg("not_square")  
  Else  
    Disp diag(m)  
    Return trace(m)  
  EndIf
```

```
Define LibPriv errmsg(msgcode)=  
Func  
© Private library function errmsg(msgcode)  
  ...  
  If msgcode="not_square" Then  
    Return "Error: matrix is not square"  
  EndIf  
  ...  
EndFunc
```

You could then use the following syntax to display the diagonal and calculate the trace of matrix *m* defined in the current problem:

```
matrix\diagwithtrace(m)
```

Creating libraries and library objects

A document is regarded as a library when it is saved or copied to the designated library folder, **MyLib**. If the folder has been inadvertently deleted, you must create it before attempting to use libraries.

You can define library objects using either the Program Editor or the Calculator application. Library objects must be defined with a **Define** command and must reside in the first problem of a library document.

Note: If you use the Program Editor to define a library function or program, you must store the object and also save the document. Saving the document does not automatically store the object. For more information, see the “Programming” section of the documentation.

Naming restrictions apply to library documents and library objects.

- A library document name must be a valid variable name between 1 and 16 characters long, and it must not contain a period or begin with an underscore.
- A library object name must be a valid variable name between 1 and 15 characters long. It must not contain a period and must not begin with an underscore.

Private and Public library objects

When you define a library object, you designate it as private (LibPriv) or public (LibPub).

Define $a = 5$

a is not a library object.


Define LibPriv $b = \{1,2,3\}$

b is a private library object.

Define LibPub $\text{func1}(x) = x^2 - 1$

func1 is a public library object.



A **Private** library object does not appear in the Catalog, but you can access it by typing its name. Private objects serve well as building blocks that perform basic, low-level tasks. Typically, private library objects are called upon by the public functions and programs.

A **Public** library object appears in the Catalog’s library tab  after you refresh the libraries. You can access a public library object through the Catalog or by typing its name.

Note: In library programs and functions defined as public, a comment line (©) immediately following the **Prgm** or **Func** line is automatically displayed as help in the Catalog. You could, for example, show a syntax reminder there.

Using short and long names



Anytime you are in the same problem where an object is defined, you can access it by entering its short name (the name given in the object's **Define** command). This is the case for all defined objects, including private, public, and non-library objects.

You can access a library object from any document by typing the object's long name. A long name consists of the name of the object's library document followed by a backslash "\ " followed by the name of the object. For example, the long name of the object defined as **func1** in the library document **lib1** is **lib1\func1**. To type the "\ " character on the handheld, press  .



Note: If you cannot remember the exact name or the order of arguments required for a private library object, you can open the library document or use the Program Editor to view the object. You also can use **getVarInfo** to view a list of objects in a library.

Using library objects


Before using a library variable, function, or program, make sure that these steps have been followed:

- The object has been defined with the **Define** command, and the command specifies either the LibPriv or LibPub attribute.
- The object resides in the first problem of a library document. The document must reside in the designated library folder and must meet the naming requirements.
- If you defined the object using the Program Editor, it has been stored using **Check Syntax & Store** from the Program Editor menu.
- The libraries have been refreshed (press   and select **Refresh Libraries**).



Using a public library object

1. Press   and select **Refresh Libraries**.
2. Open the TI-Nspire™ application in which you want to use the variable, function or program.

Note: All applications can evaluate functions, but only the Calculator application can run programs.



3. Open the Catalog and use the library tab  to find and insert the object.

- or -



Type the name of the object, such as `lib1\func1()`. In case of a function or program, always follow the name with parentheses. To type the “\” character on the handheld, press  .

4. If arguments are required, type them inside the parentheses.

Using a private library object

1. Press   and select **Refresh Libraries**.
2. Open the TI-Nspire™ application in which you want to use the variable, function or program.

Note: All applications can evaluate functions, but only the Calculator application can run programs.



3. Type the name of the object, such as `lib1\func1()`.
In case of a function or program, always follow the name with parentheses. To type the “\” character on the handheld, press  .
4. If arguments are required, type them inside the parentheses.

Creating shortcuts to library objects

You can make the objects in a library more easily accessible by using **libShortcut()** to create shortcuts to them. This creates a variable group in the current problem that contains references to all the objects in the specified library document. You can choose to include or exclude the private library objects.

For example, suppose the library document `linalg` contains functions named `clearmat`, `cofactor`, `gausstep`, `help`, `inversestep`, `kernelbasis`, `rank`, and `simultstep`. Executing **libShortcut("linalg","la")** would create a variable group containing the following members:

`la.clearmat`
`la.cofactor`
`la.gausstep`
`la.help`
`la.inversestep`
`la.kernelbasis`
`la.rank`
`la.simultstep`

You can refer to those library objects from within the current problem by typing their variable names or by selecting them from the Variables menu (press  .

For details and an example of using **libShortcut()**, refer to the Reference Guide.



Included libraries

To help you get started with libraries, the TI-Nspire™ CAS installation includes a library document with useful Linear Algebra functions. The library is named **linalgCAS** and is installed in the designated library folder.

Note: Updating the handheld's operating system places the included libraries in the default folder, **MyLib**. If you have edited an object in an included library or replaced an included library with your own document of the same name, updating your handheld's operating system will overwrite your changes.

Restoring an included library

If you inadvertently delete or overwrite an included library, you can restore it from the installation CD.

1. Open the CD, and navigate to the **libs** folder.
2. Identify the library file to restore, such as **linalgCAS.tns** for the linear algebra library.
3. Connect the handheld to your computer, open the TI-Nspire™ Computer Link Software, and copy the library file to the handheld's **MyLib** folder.
4. On the handheld, press  , and select **Refresh Libraries** to activate the new library objects.

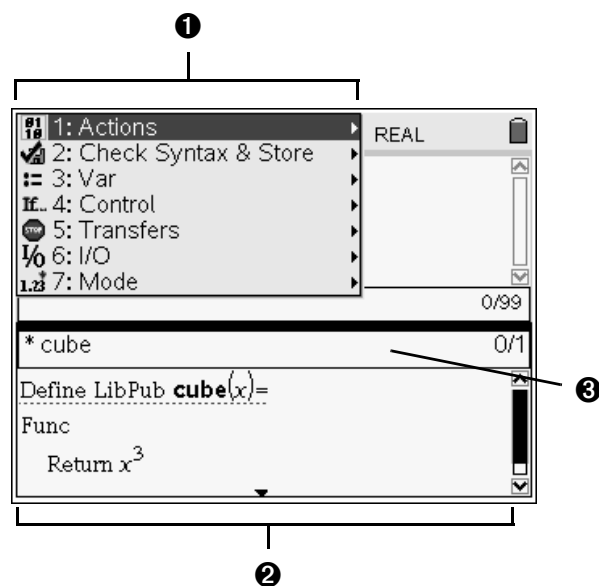
Programming


You can create user-defined functions or programs by typing definition statements on the Calculator entry line or by using the Program Editor. The Program Editor offers some advantages, and it is covered in this section. For information on defining programs and functions in Calculator, see the “Calculator” chapter.

Overview of the Program Editor

The Program Editor helps you define, edit, and manage user-defined functions and programs.



- The editor has programming templates and dialog boxes to help you define functions and programs using correct syntax.
- The editor lets you enter multiple-line programming statements without requiring a special key sequence to add each line.
- You can easily create private and public library objects (variables, functions, and programs). For details, see the “Libraries” chapter.
- The editor is accessible from the **Tools > Insert** menu as well as from the Calculator’s **Functions & Programs** menu.









- 1** Program Editor menu – This menu is available anytime you are in the Program Editor work area. Press  to display the menu.

- ② Program Editor work area
- ③ Status line shows line number information and the name of the function or program being edited. An asterisk (*) indicates that this function is “dirty,” which means that it has changed since the last time its syntax has been checked and it has been stored.

The Program Editor menu

Menu Name	Menu Option	Function
 	Actions	
	New	Displays a dialog box for defining a new function or program.
	Open	Lets you open an existing library function or program for editing.
	Import	Imports a program or function from a library.
	View	Lets you view (and optionally, edit) an existing library function or program.
	Create Copy	Lets you copy the current function or program.
	Rename	Lets you rename the current function or program.
	Change Library Access	Lets you change the access level of a library object to private (LibPriv), public (LibPub), or none.
	Insert Comment	Inserts a comment (©) at the cursor position.
	Find	Displays a dialog box for text search.
	Find and Replace	Lets you find and, optionally, replace occurrences of specified text.



Menu Name	Menu Option	Function
	Go to Line	Moves the cursor to a specified line number.
	Go Back	Lets you easily return from the Program Editor to the Calculator or Notes application after a runtime error occurs.
	Close	Closes the current function or program.
 Check Syntax & Store		
	Check Syntax & Store	Finds syntax errors and tries to put the cursor near the first error. If no errors, stores current function or program.
	Check Syntax	Finds syntax errors and tries to put the cursor near the first error.
 Define Variables		
	Local	Inserts Local .
	Define	Inserts Define .
	Delete Variable	Inserts DelVar .
	Func...EndFunc	Inserts Func...EndFunc template.
	Prgm...EndPrgm	Inserts Prgm...EndPrgm template.
 If... Control		
	If	Inserts If statement.
	If...Then...EndIf	Inserts If...Then...EndIf template.
	If...Then...Else...EndIf	Inserts If...Then...Else...EndIf template.

Menu Name	Menu Option	Function
	Elseif...Then	Inserts Elseif...Then template.
	For...EndFor	Inserts For...EndFor template.
	While...EndWhile	Inserts While...EndWhile template.
	Loop...EndLoop	Inserts Loop...EndLoop template.
	Try...Else...EndTry	Inserts Try...Else...EndTry template.
	ClrErr	Inserts ClrErr .
	PassErr	Inserts PassErr .
 Transfer		
	Return	Inserts return() .
	Cycle	Inserts Cycle .
	Exit	Inserts Exit .
	Lbl	Inserts Lbl (label).
	Go to Lbl	Inserts Goto .
	Stop	Inserts Stop .
 Input/Output		
	Disp	Inserts the Disp (display) command.
 Mode		
	Display Digits	Lets you select from several Float and Fix settings.
	Angle	Lets you select Degrees, Radians, or Gradians.
	Exponential Format	Lets you select Normal, Scientific, or Engineering.


Menu Name	Menu Option	Function
	Real or Complex	Lets you select Real, Rectangular, or Polar.
	Auto or Approx	Lets you select Auto, Approximate, or Exact results.
	Vector Format	Lets you select Rectangular, Cylindrical, or Spherical.
	Base	Lets you select Decimal, Hex, or Binary.
	Unit System	Lets you select SI or Eng/US.
	GetMode	Inserts getMode() .
	Get Language Info	Inserts getLangInfo() .

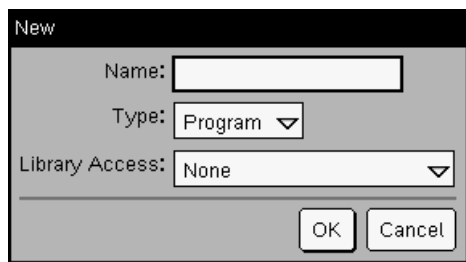
Defining a program or function

Starting a new Program Editor

1. If you are not on a Calculator page, press  , and then select **Insert > Program Editor > New**.

- or -

If you are on a Calculator page, press  to display the Calculator menu, and then select **Functions & Programs > Program Editor > New**.



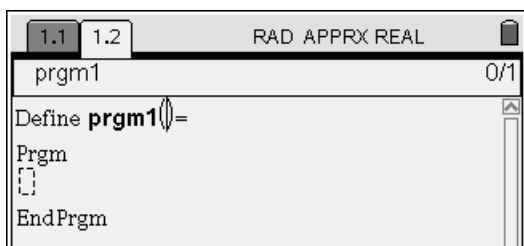
2. Type a name for the function or program you are defining.
3. Select the **Type (Program or Function)**.

4. Set the **Library Access**:

- If you want to use the function or program only from the current document and problem, select **None**.
- If you want the function or program to be accessible from any document but not visible in the Catalog, select **LibPriv**.
- If you want the function or program to be accessible from any document and also visible in the Catalog, select **LibPub (Show in Catalog)**. For details, see the “Libraries” chapter.

5. Click **OK**.

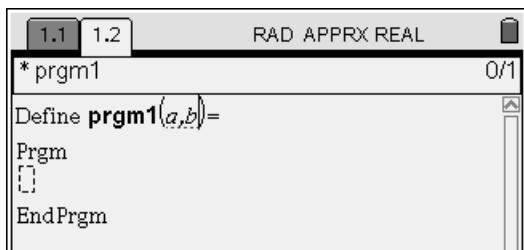
A new instance of the Program Editor opens, with a template matching the selections you made.



Entering lines into a function or program

The Program Editor does not execute the commands or evaluate expressions as you enter them. They are executed only when you evaluate the function or run the program.

1. If your function or program will require the user to supply arguments, type parameter names in the parentheses that follow the name. Separate parameters with a comma.



2. Between the Func and EndFunc (or Prgm and EndPrgm) lines, enter the lines of statements that make up your function or program.

```

1.1 1.2 RAD APPRX REAL
* prgm1 3/3
Define prgm1(a,b)=
Prgm
  Disp "a=",a
  Disp "b=",b
  Disp "a^b=",a^b
EndPrgm

```

- You can either type the names of functions and commands or insert them from the Catalog.
- A line can be longer than the width of the screen; if so, you might have to scroll to view the entire statement.
- After typing each line, press ENTER . This inserts a new blank line and lets you continue entering another line.
- Use the \leftarrow , \rightarrow , \uparrow , and \downarrow arrow keys to scroll through the function or program for entering or editing commands.

Inserting comments

A comment symbol (©) lets you enter a remark. Comments can be useful to someone viewing or editing the program. Comments do not display when the program runs, and they have no effect on program flow.

```

Define LibPub volcyl(ht,r) =
Prgm
©volcyl(ht,r) => volume of cylinder ❶
  Disp "Volume =", approx( $\pi \cdot r^2 \cdot ht$ )
©This is another comment.

```

- ❶ Comment showing required syntax. Because this library object is public and this comment is the first line in a Func or Prgm block, the comment displays in the Catalog as help. For details, see the “Libraries” chapter.


To insert a comment:

1. Position the cursor at the end of the line where you want to insert a comment.
2. Press MENU to display the Program Editor menu.
3. Select **Actions**, and then select **Insert Comment**.

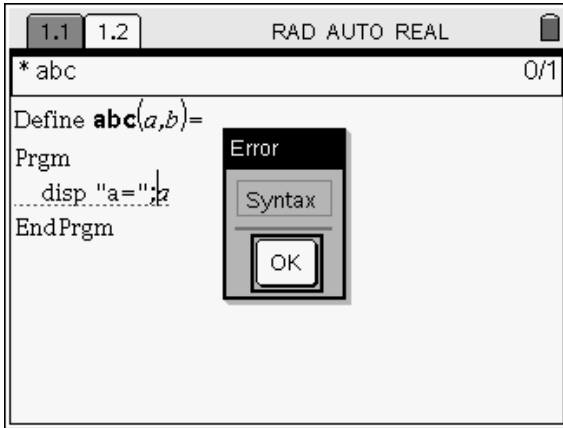
4. Type the text of the comment after the © symbol.

Checking syntax

The Program Editor lets you check the function or program for correct syntax.

1. Press  to display the Program Editor menu.
2. Select **Check Syntax & Store**, and then select **Check Syntax**.


If the syntax checker finds any syntax errors, it displays an error message and tries to position the cursor near the first error so you can correct it.



Storing the function or program


You must store your function or program to make it accessible. The Program Editor automatically checks the syntax before storing.

An asterisk (*) is displayed in the upper left corner of the Program Editor to indicate that the function or program has not been stored.

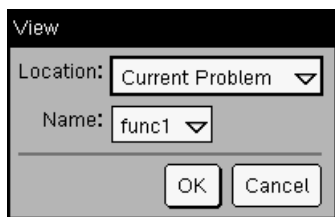
1. Press  to display the Program Editor menu.
2. Select **Check Syntax & Store**, and then select **Check Syntax & Store**.
 - If the syntax checker finds any syntax errors, it displays an error message and tries to position the cursor near the first error.
 - If no syntax errors are found, the message "Stored successfully" is displayed in the status line at the top of the Program Editor.

Note: If the function or program is defined as a library object, you must also save the document in the designated library folder and refresh libraries to make the object accessible to other documents. For details, see the “Libraries” chapter.

Viewing an existing program or function

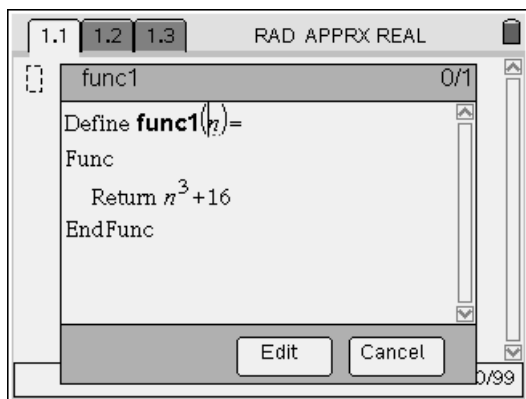
1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **View**.

The View dialog box displays.



3. If the function or program is a library object, select its library from the **Location** list.
4. Select the function or program name from the **Name** list.

The function or program displays in a viewer.



5. Use the arrow keys to view the function or program.

- When finished viewing, select **Edit** (press **tab**) to highlight **Edit**, and then press **enter** to open the function or program in the Program Editor, or press **esc** to close the viewer.

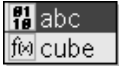
Note: The **Edit** selection is available only for functions and programs defined in the current problem. To edit a library object, you must first open its library document.

Opening an existing function or program

You can open a function or program from the current problem only.

- Press **menu** to display the Program Editor menu.
- Select **Actions**, and then select **Open**.

A list of available functions and programs displays.



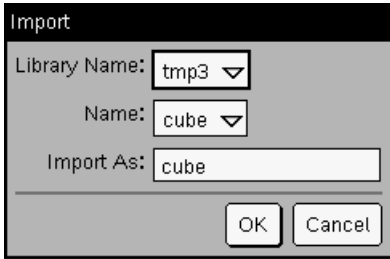
- Select the item to open.

Importing a program from a library

You can import a function or program defined as a library object into a Program Editor within the current problem.

- Press **menu** to display the Program Editor menu.
- Select **Actions**, and then select **Import**.


The Import dialog box displays.



- Select the **Library Name**.
- Select the **Name** of the object.
- If you want the imported object to have a different name, type the name under **Import As**.


Creating a copy of a function or program

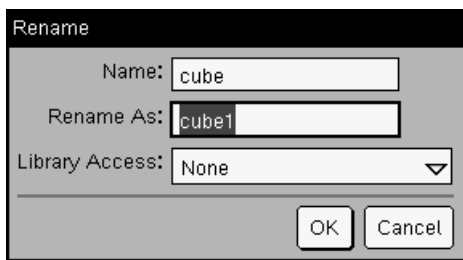
When creating a new function or program, you might find it easier to start with a copy of the current one.

1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Create Copy**.
The Create Copy dialog box displays.
3. Type a new name, or click **OK** to accept the proposed name.
4. If you want to change the access level, select **Library Access**, and select a new level.

Renaming a program or function


You can rename and (optionally) change the access level of the current function or program.

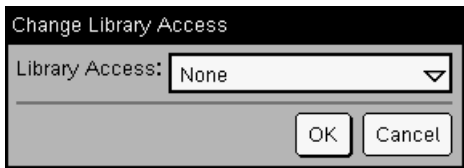
1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Rename**.
A dialog box displays, with a proposed name.



3. Type a new name, or click **OK** to accept the proposed name.
4. If you want to change the access level, select **Library Access**, and select a new level.


Changing the library access level

1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Change Library Access**.



3. Select the **Library Access**:
 - If you want to use the function or program only from the current Calculator problem, select **None**.
 - If you want the function or program to be accessible from any document but not visible in the Catalog, select **LibPriv**.
 - If you want the function or program to be accessible from any document and also visible in the Catalog, select **LibPub**.


Finding text

1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Find**.



3. Type the text that you want to find, and click **OK**.
 - If the text is found, it is highlighted in the program.
 - If the text is not found, a notification message displays.


Finding and replacing text

1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Find and Replace**.



3. Type the text that you want to find.
4. Type the replacement text.
5. Click **Replace** to replace the first occurrence after the cursor position, or click **Replace All** to replace every occurrence.


Closing the current function or program

1. Press  to display the Program Editor menu.
2. Select **Actions**, and then select **Close**.
3. If the function or program has unstored changes, you are prompted to check syntax and store before closing.

Running programs and evaluating functions



After defining and storing a function or program, you can use it from an application. All the applications can evaluate functions, but only the Calculator application can run programs.

The program statements are executed in sequential order (although some commands alter the program flow). The output, if any, is displayed in the application's work area.

- Program execution continues until it reaches the last statement or a **Stop** command.
- Function execution continues until it reaches a **Return** command.
- To stop a program or function manually, hold down the  key for several seconds.

Using short and long names

Anytime you are in the same problem where an object is defined, you can access it by entering its short name (the name given in the object's **Define** command). This is the case for all defined objects, including private, public, and non-library objects.


You can access a library object from any document by typing the object's long name. A long name consists of the name of the object's library document followed by a backslash "\ " followed by the name of the object. For example, the long name of the object defined as **func1** in the library document **lib1** is **lib1\func1**. To type the "\ " character on the handheld, press  .

Note: If you cannot remember the exact name or the order of arguments required for a private library object, you can open the library document or use the Program Editor to view the object. You also can use **getVarInfo** to view a list of objects in a library.

Using a Public library function or program

1. Make sure you have defined the object in the document's first problem, stored the object, saved the library document in the MyLib folder, and refreshed the libraries.
2. Open the TI-Nspire™ application in which you want to use the function or program.

Note: All applications can evaluate functions, but only the Calculator application can run programs.

3. Open the Catalog and use the library tab  to find and insert the object.

- or -

Type the name of the object. In the case of a function or program, always follow the name with parentheses.

```
libs2\func1()
```

4. If the program requires you to supply one or more arguments, type the values or variable names inside the parentheses.

```
libs2\func1(34, power)
```

5. Press .

Using a Private library function or program

To use a Private library object, you must know its long name. For example, the long name of the object defined as **func1** in the library document **lib1** is **lib1\func1**.

Note: If you cannot remember the exact name or the order of arguments required for a private library object, you can open the library document or use the Program Editor to view the object.

1. Make sure you have defined the object in the document's first problem, stored the object, saved the library document in the MyLib folder, and refreshed the libraries.
2. Open the TI-Nspire™ application in which you want to use the function or program.

Note: All applications can evaluate functions, but only the Calculator application can run programs.

3. Type the name of the object. In the case of a function or program, always follow the name with parentheses.


```
libs2\func1()
```

4. If the object requires you to supply one or more arguments, type the values or variable names inside the parentheses.

```
libs2\func1(34,power)
```

5. Press .

Running a non-library program or function

1. Make sure you are in the same problem in which the function or program is defined.
2. Type the name of the function or program on the entry line, or press  to select the name from a list.

You must always include a set of parentheses after the name.

```
prog1()
```


If the function or program requires you to supply one or more arguments, type the values or variable names inside the parentheses.

```
prog1(34,power)
```


3. Press .

Interrupting a running program

While a function or program is running, the busy pointer ☹ displays.

- ▶ Press and hold  for several seconds to stop program execution.

A message displays.

- To edit the function or program in the Program Editor, select **Go To**. The cursor appears at the command where the break occurred.
- To close the message box, press .

Getting values into a program

To input values into a function or program, you can:

- Require users to store values to specific variables beforehand. The object can then refer to these variables.

```
Define calculatearea() =  
Prgm  
  area:=wt*ht  
EndPrgm
```

- Embed the values directly in the object itself.

```
Define calculatearea() =  
Prgm  
  wt:=3  
  ht:=23  
  area:=wt*ht  
EndPrgm
```

- Use parameters in the definition. This lets users pass one or more values as arguments to the object when they use it.

```
Define calculatearea(wt,ht) =  
Prgm  
  area:=wt*ht  
EndPrgm
```

Example of passing values to a program

The following program, **volcyl**, calculates the volume of a cylinder. Two values must be passed to the program. The first value must be the height, and the second value must be the radius.

When you define the program in the Program Editor, you specify in parentheses the parameters that will be used to store the passed values. The parameters are placeholders, so their order is important. The names you choose should be names that remind you which information to supply.

1. Define the **volcyl** program.

```
Define volcyl(height,radius) =  
Prgm  
    Disp "Volume =", approx( $\pi \cdot \text{radius}^2 \cdot$   
height)  
EndPrgm
```

2. Run the program to display the volume of a cylinder with a height of 34 mm and a radius of 5 mm.

```
volcyl(34,5)           Volume = 534.071
```

Note: You do not have to use the parameter names when you run the **volcyl** program, but you must supply two arguments (as values, variables, or expressions). The first must represent the height, and the second must represent the radius.

Displaying information

A running function or program does not display intermediate calculated results unless you include a **Disp** command. This is an important difference between performing a calculation on the entry line and performing it in a function or program.

These calculations do not display a result in a function or program (although they do from the entry line).

```
12•6  
cos( $\pi/4$ )
```

Disp displays calculation result or text in a function or program.

```
Disp 12•6  
Disp "Result:", cos( $\pi/4$ )
```

Displaying a result does not store that result. If you expect to refer later to a result calculated in a program, store the result to a global variable.

```
cos( $\pi/4$ ) → maximum  
Disp maximum
```

Using local variables

A local variable is a temporary variable that exists only while a user-defined function is being evaluated or a user-defined program is running.

Example of a local variable

The following program segment shows a **For...EndFor loop** (which is discussed later in this module). The variable *i* is the loop counter. In most cases, the variable *i* is used only while the program is running.

```
Local i ❶  
For i, 0, 5, 1  
    Disp i  
EndFor
```

❶ Declares variable *i* as local.

Note: When possible, declare as local any variable that is used only within the program and does not need to be available after the program stops.

What causes an undefined variable error message?

An **Undefined** variable error message displays when you evaluate a user-defined function or run a user-defined program that references a local variable that is not initialized (assigned a value).

For example:

```
Define fact(n) = Func  
    Local m ❶  
    While n > 1  
        n * m → m: n - 1 → n  
    EndWhile
```

❶ Local variable *m* is not assigned an initial value.

You must initialize local variables

All local variables must be assigned an initial value before they are referenced.

```
Define fact(n)=Func
  Local m: 1→m ❶
  While n>1
    n*m→m: n-1→n
  EndWhile
```

❶ 1 is stored as the initial value for m .

Note: Functions and programs cannot use a local variable to perform symbolic calculations.

Performing symbolic calculations

If you want a function or program to perform symbolic calculations, you must use a global variable instead of a local. However, you must be certain that the global variable does not already exist outside of the program. The following methods can help.

- Refer to a global variable name, typically with two or more characters, that is not likely to exist outside of the function or program.
- Include **DelVar** within a program to delete the global variable, if it exists, before referring to it. (**DelVar** does not delete locked or linked variables.)

Differences between functions and programs

A function defined in the Program Editor is very similar to the functions built into the TI-Nspire™ CAS handheld.

- Functions must return a result, which can be graphed or entered in a table. Programs cannot return a result.
- You can use a function (but not a program) within an expression. For example: $3 \cdot \text{func1}(3)$ is valid, but not $3 \cdot \text{prog1}(3)$.
- You can run programs from Calculator only. However, you can evaluate functions in Calculator, Notes, Lists & Spreadsheet, Graphs & Geometry, and Data & Statistics.

- A function can refer to any variable; however, it can store a value to a local variable only. Programs can store to local and global variables.
Note: Arguments used to pass values to a function are treated as local variables automatically. If you want to store to any other variables, you must declare them as **Local** from within the function.
- A function cannot call a program as a subroutine, but it can call another user-defined function.
- You cannot define a program within a function.
- A function cannot define a global function, but it can define a local function.

Calling one program from another

One program can call another program as a subroutine. The subroutine can be external (a separate program) or internal (included in the main program). Subroutines are useful when a program needs to repeat the same group of commands at several different places.

Calling a separate program

To call a separate program, use the same syntax that you use to run the program from the entry line.

```

Define subtest1() =
Prgm
  For i,1,4,1
    subtest2(i,i*1000)
  EndFor
Define subtest2(x,y) =
Prgm
  Disp x,y
EndPrgm

```

Defining and calling an internal subroutine

To define an internal subroutine, use the **Define** command with **Prgm...EndPrgm**. Because a subroutine must be defined before it can be called, it is a good practice to define subroutines at the beginning of the main program.

An internal subroutine is called and executed in the same way as a separate program.

```

Define subtest1()=
  Prgm
  local subtest2 ❶
  Define subtest2(x,y)= ❷
  Prgm
    Disp x,y
  EndPrgm
  ©Beginning of main program
  For i,1,4,1
    subtest2(i,I*1000) ❸

```

- ❶ Declares the subroutine as a local variable.
- ❷ Defines the subroutine.
- ❸ Calls the subroutine.

Note: Use the Program Editor's **Var** menu to enter the **Define** and **Prgm...EndPrgm** commands.

Notes about using subroutines

At the end of a subroutine, execution returns to the calling program. To exit a subroutine at any other time, use **Return** with no argument.

A subroutine cannot access local variables declared in the calling program. Likewise, the calling program cannot access local variables declared in a subroutine.

Lbl commands are local to the programs in which they are located. Therefore, a **Goto** command in the calling program cannot branch to a label in a subroutine or vice versa.

Avoiding circular-definition errors

When evaluating a user-defined function or running a program, you can specify an argument that includes the same variable that was used to define the function or create the program. However, to avoid circular-definition errors, you must assign a value for variables that are used in evaluating the function or running the program. For example:

```
x+1→x ❶
```

– or –

```
For i,i,10,1
  Disp i ❶
EndFor
```

- ❶ Causes a **Circular definition** error message if x or i does not have a value. The error does not occur if x or i has already been assigned a value.

Controlling the flow of a function or program

When you run a program or evaluate a function, the program lines are executed in sequential order. However, some commands alter the program flow. For example:

- Control structures such as **If...EndIf** commands use a conditional test to decide which part of a program to execute.
- Loop commands such as **For...EndFor** repeat a group of commands.

Using If, Lbl, and Goto to control program flow

The **If** command and several **If...EndIf** structures let you execute a statement or block of statements conditionally, that is, based on the result of a test (such as $x > 5$). **Lbl** (label) and **Goto** commands let you branch, or jump, from one place to another in a function or program.

The **If** command and several **If...EndIf** structures reside on the Program Editor's **Control** menu.

When you insert a structure such as **If...Then...EndIf**, a template is inserted at the cursor location. The cursor is positioned so that you can enter a conditional test.

If command

To execute a single command when a conditional test is true, use the general form:

```
If x>5
  Disp "x is greater than 5" ❶
Disp x ❷
```

- ❶ Executed only if $x > 5$; otherwise, skipped.
- ❷ Always displays the value of x.

In this example, you must store a value to `x` before executing the **If** command.

If...Then...EndIf structures

To execute one group of commands if a conditional test is true, use the structure:

```
If x>5 Then
    Disp "x is greater than 5" ❶
    2*x→x ❶
EndIf
Disp x ❷
```

- ❶ Executed only if $x > 5$.
- ❷ Displays the value of:
 - 2x if $x > 5$
 - x if $x \leq 5$

Note: **EndIf** marks the end of the **Then** block that is executed if the condition is true.

If...Then...Else... EndIf structures

To execute one group of commands if a conditional test is true and a different group if the condition is false, use this structure:

```
If x>5 Then
    Disp "x is greater than 5" ❶
    2*x→x ❶
Else
    Disp "x is less than or equal to 5" ❷
    5*x→x ❷
EndIf
Disp x ❸
```

- ❶ Executed only if $x > 5$.
- ❷ Executed only if $x \leq 5$.
- ❸ Displays value of:
 - 2x if $x > 5$
 - 5x if $x \leq 5$

If...Then...Elseif... Endif structures

A more complex form of the **If** command lets you test for multiple conditions. Suppose you want a program to test a user-supplied argument that signifies one of four options.

To test for each option (If Choice=1, If Choice=2, and so on), use the **If...Then...Elseif...Endif** structure.

Lbl and Goto commands

You can also control the flow by using **Lbl** (label) and **Goto** commands. These commands reside on the Program Editor's **Transfers** menu.

Use the **Lbl** command to label (assign a name to) a particular location in the function or program.

Lbl *labelName*

└─ name to assign to this location (use the same naming convention as a variable name)

You can then use the **Goto** command at any point in the function or program to branch to the location that corresponds to the specified label.

Goto *labelName*

└─ specifies which **Lbl** command to branch to

Because a **Goto** command is unconditional (it always branches to the specified label), it is often used with an **If** command so that you can specify a conditional test. For example:

```
If x>5
  Goto GT5 ❶
Disp x
-----
----- ❷
Lbl GT5
Disp "The number was > 5"
```

- ❶ If $x > 5$, branches directly to label GT5.
- ❷ For this example, the program must include commands (such as **Stop**) that prevent **Lbl** GT5 from being executed if $x \leq 5$.

Using loops to repeat a group of commands

To repeat the same group of commands successively, use one of the loop structures. Several types of loops are available. Each type gives you a different way to exit the loop, based on a conditional test.

Loop and loop-related commands reside on the Program Editor's **Control** and **Transfers** menus.

When you insert one of the loop structures, its template is inserted at the cursor location. You can then begin entering the commands that will be executed within the loop.

For...EndFor loops

A **For...EndFor** loop uses a counter to control the number of times the loop is repeated. The syntax of the **For** command is:

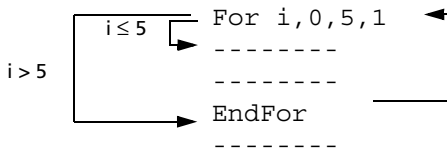
Note: The ending value can be less than the beginning value, provided the increment is negative.

For *variable*, *begin*, *end* [, *increment*]

① ② ③ ④

- ① *Variable* used as a counter
- ② Counter value used the first time **For** is executed
- ③ Exits the loop when *variable* exceeds this value
- ④ Added to the counter each subsequent time **For** is executed (If this optional value is omitted, the *increment* is 1.)

When **For** is executed, the *variable* value is compared to the *end* value. If *variable* does not exceed *end*, the loop is executed; otherwise, control jumps to the command following **EndFor**.



Note: The **For** command automatically increments the counter variable so that the function or program can exit the loop after a certain number of repetitions.

At the end of the loop (**EndFor**), control jumps back to the **For** command, where the variable is incremented and compared to *end*.

For example:

```

For i, 0, 5, 1
  Disp i ❶
EndFor
Disp i ❷

```

❶ Displays 0, 1, 2, 3, 4, and 5.

❷ Displays 6. When *variable* increments to 6, the loop is not executed.

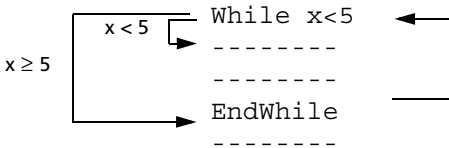
Note: You can declare the counter variable as local if it does not need to be saved after the function or program stops.

While...EndWhile loops

A **While...EndWhile** loop repeats a block of commands as long as a specified condition is true. The syntax of the **While** command is:

While *condition*

When **While** is executed, *condition* is evaluated. If *condition* is true, the loop is executed; otherwise, control jumps to the command following **EndWhile**.



Note: The **While** command does not automatically change the condition. You must include commands that allow the function or program to exit the loop.

At the end of the loop (**EndWhile**), control jumps back to the **While** command, where condition is re-evaluated.

To execute the loop the first time, the condition must initially be true.

- Any variables referenced in the condition must be set before the **While** command. (You can build the values into the function or program, or you can prompt the user to enter the values.)
- The loop must contain commands that change the values in the condition, eventually causing it to be false. Otherwise, the condition is always true and the function or program cannot exit the loop (called an infinite loop).

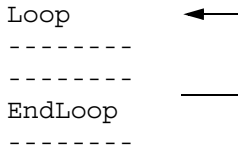
For example:


```
0→x ①
While x<5
  Disp x ②
  x+1→x ③
EndWhile
Disp x ④
```

- ① Initially sets x .
- ② Displays 0, 1, 2, 3, and 4.
- ③ Increments x .
- ④ Displays 5. When x increments to 5, the loop is not executed.

Loop...EndLoop loops

A **Loop...EndLoop** creates an infinite loop, which is repeated endlessly. The **Loop** command does not have any arguments.



Typically, you insert commands in the loop that let the program exit from the loop. Commonly used commands are: **If**, **Exit**, **Goto**, and **Lbl** (label). For example:

```
0→x
Loop
  Disp x
  x+1→x
  If x>5 ①
    Exit
EndLoop
Disp x ②
```

- ① An **If** command checks the condition.
- ② Exits the loop and jumps to here when x increments to 6.

Note: The **Exit** command exits from the current loop.

In this example, the **If** command can be anywhere in the loop.

When the If command is:	The loop is:
At the beginning of the loop	Executed only if the condition is true.
At the end of the loop	Executed at least once and repeated only if the condition is true.

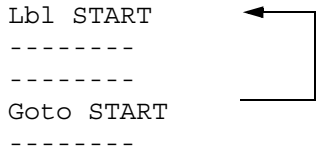
The **If** command could also use a **Goto** command to transfer program control to a specified **Lbl** (label) command.

Repeating a loop immediately

The **Cycle** command immediately transfers program control to the next iteration of a loop (before the current iteration is complete). This command works with **For...EndFor**, **While...EndWhile**, and **Loop...EndLoop**.

Lbl and Goto loops

Although the **Lbl** (label) and **Goto** commands are not strictly loop commands, they can be used to create an infinite loop. For example:




As with **Loop...EndLoop**, the loop should contain commands that let the function or program exit from the loop.

Changing mode settings

Functions and programs can use the **setMode()** function to temporarily set specific calculation or result modes. The Program Editor's **Mode** menu makes it easy to enter the correct syntax without requiring you to memorize numeric codes.

Note: Mode changes made within a function or program definition do not persist outside the function or program.

Setting a mode

1. Position the cursor where you want to insert the **setMode** function.
2. Press  to display the Program Editor menu.
3. On the **Mode** menu, select the mode to display a menu of its valid settings.

4. Select a setting.

The correct syntax is inserted at the cursor location. For example:

```
setMode(1,3)
```


Debugging programs and handling errors

After you write a function or program, you can use several techniques to find and correct errors. You can also build an error-handling command into the function or program itself.

If your function or program allows the user to select from several options, be sure to run it and test each option.

Techniques for debugging

Run-time error messages can locate syntax errors but not errors in program logic. The following techniques may be useful.

- Temporarily insert **Disp** commands to display the values of critical variables.
- To confirm that a loop is executed the correct number of times, use **Disp** to display the counter variable or the values in the conditional test.
- To confirm that a subroutine is executed, use **Disp** to display messages such as “Entering subroutine” and “Exiting subroutine” at the beginning and end of the subroutine.
- To stop a program or function manually, hold down the  key for several seconds.

Error-handling commands

Command	Description
Try...EndTry	Defines a block that lets a function or program execute a command and, if necessary, recover from an error generated by that command.
ClrErr	Clears the error status and sets the error number in system variable Errornum to zero.
PassErr	Passes an error to the next level of the Try...EndTry block.

Data Collection

The Data Collection Console enables you to collect experimental data from a sensor and automatically display it in a list and/or graph for analysis. Data Collection works with the Lists & Spreadsheet, Data & Statistics, and Graphs & Geometry applications. Refer to the chapters for these applications to learn about analyzing collected data.

Compatible sensor interfaces

The Data Collection Console interacts with the following USB sensor interfaces:

- Vernier EasyTemp® USB Temperature Sensor
- Texas Instruments CBR2™ Motion Detector
- Vernier Go!™ Motion Motion Detector
- Vernier Go!™ Temp USB Temperature Sensor
- Vernier Go!™ Link (with associated sensors)
- Vernier EasyLink® (with associated sensors)

Analyzing experimental data

The Data Collection Console lets you monitor and control data collection while using a TI-Nspire™ handheld or a computer running TI-Nspire™ computer software. Data collection configuration settings such as number of samples, units of measurement, and sampling rate are preconfigured to work with the sensors. You can also modify the data collection settings from the Data Collection Console.

Open the Data Collection Console to control data collection during experiments that monitor distance, temperature, motion, pressure, or other types of data supported by the compatible sensor interfaces. As you collect experimental data, you can navigate between the console and Lists & Spreadsheet, Data & Statistics, and Graphs & Geometry applications. The applications that support Data Collection Console use show data collected in real-time. For example, temperatures measured display in the associated List & Spreadsheet cells as the temperature sensor measures them.

Note: Real-time display of data collection is supported for sampling rates of 20 samples per second, or lower. For higher sampling rates, data collected data displays at the end of the run (after data collection stops). For example, when a sensor samples at a rate of 30 samples per second, a Graphs & Geometry plot that reflects the sensor's measurements displays after the run ends (not while the data is being collected).

Launching the Data Collection Console

The Data Collection Console launches automatically when a sensor is connected, or you can launch it manually from the **Insert** menu.

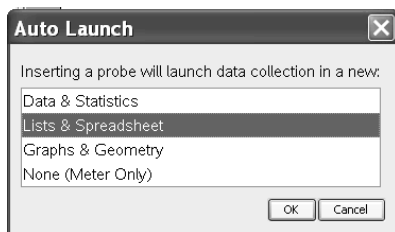
Note: If you open a TI-Nspire™ document (.tns file) with data collection pages created using a TI-Nspire™ operating system earlier than Version 1.4, data is preserved, but experiment-related settings are not.

Using Auto Launch

Auto Launch occurs when you attach a supported USB sensor or interface to a TI-Nspire™ handheld or to a computer running the TI-Nspire™ computer software for math and science.

1. Connect a supported USB sensor or interface to either a TI-Nspire™ handheld or to a computer running the TI-Nspire™ computer software.

The Auto Launch dialog displays:

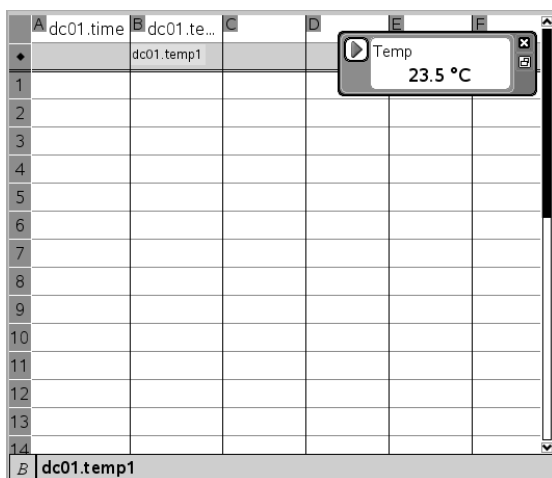


If more than one document is open (on a computer), you are asked to select which document to use.

2. Select Data & Statistics, Lists & Spreadsheet, or Graphs & Geometry as the application to use with the Data Collection Console and click **OK**.

The Data Collection Console displays. If you selected an application on the **Auto Launch** dialog, that application displays.

The following example shows a Lists & Spreadsheet application added to the page after the Data Collection Console Auto Launches.



Data Collection Console ready for temperature versus time experiment


The Data Collection Console determines the type of sensor connected and operates according to the default configuration.

Manually starting the Data Collection Console

You need to start the Data Collection Console from the **Insert** menu when the console is closed and the following conditions exist:

- A sensor from a previous data collection run is still attached and you need to start data collection again.
- A new problem requires data collection.
- An experiment requires sensor-dependent data collection changes.

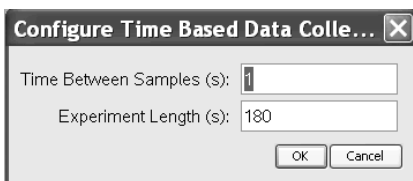
To manually start data collection:

1. Attach a compatible USB sensor to the TI-Nspire™ handheld or to the computer with the TI-Nspire™ computer software for math and science running.
2. Press  **D**.

The Data Collection Console opens. If the attached sensor measures conditions that are present, the console displays the values measured. The values displayed are not represented in applications until you set the data collection operation mode and start data collection.

3. To enable a supported application to respond to the sensor, select **Display Data In > App(s) on Current Page** from the **Experiment** menu . This option allows supported applications to display data collection details (variable name labels, values in a spreadsheet, and points in a plot):
 - A graphing application (Graphs & Geometry or Data & Statistics) on the page adds the data collection variables as labels on the appropriate axes.
 - Lists & Spreadsheet adds the names of the variables for data collection to column headings.
4. Choose **Set Up Collection** to set an operation mode for use with data collection:
 - Choose **Time Graph** to use the time-controlled operation for a run:

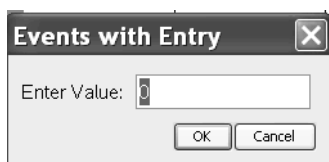
When you choose Time Graph mode, type the number of seconds to wait between samples and the number of seconds for the duration of the experiment on the **Configure Time Based Data Collection** dialog.




The preceding **Configure Time Based Data Collection** dialog is from a temperature sensor. For this example, the default settings collect a measurement each second and continue to collect data for 180 seconds. You can modify the default settings for a sensor; the settings available differ based on the sensor type.

- Choose **Events with Entry** to specify samples manually for a set of events that you define. Each time you press **Keep**, the **Events with Entry** dialog displays to let you enter a value for the dependent variable. For example, to examine the relationship between pressure and volume, you can manually sample a pressure reading on a pressure sensor. The sample pressure

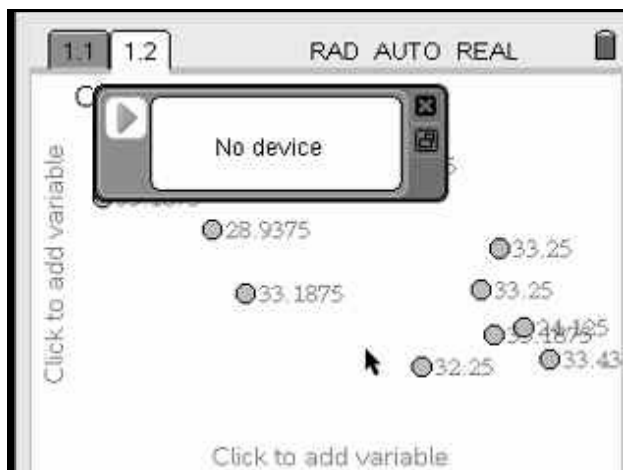
reading you type in the **Enter Value** is the corresponding value for the volume of a liquid in a container.



- Choose **Selected Events** to collect a displayed measurement and use an automatically assigned sequential event number each time you press **Keep** during data collection.
5. Press  on the Data Collection Console to start collecting data.


The Data Collection Console detects the sensor settings specified in Steps 4 and 5.

The following examples illustrate how the Data Collection Console and the Data & Statistics application appear when data collection is in progress.



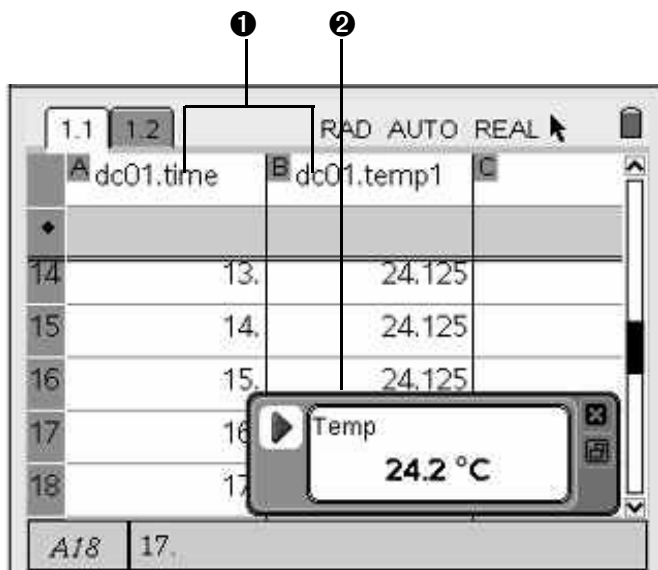
Note: The Data Collection Console is active for one problem at a time. If you leave the problem while data collection is active, the Data Collection Console displays a confirmation dialog and data collection ends.

6. For an event-based data collection mode (Selected Events or Events with Entry), you must press **Keep**  to collect and store the sensor data.

7. Press  to stop data collection at any time. With the Time Graph operation mode, data collection stops automatically after the specified duration for the experiment is reached.

Getting started with the Data Collection Console

After you insert a Data Collection Console, the meter displays in the work area.



- 1 Data collection variables added to column headings in a Lists & Spreadsheet application
- 2 Data Collection Console with measurement display and buttons (meter for temperature Sensor shown)

Using the Data Collection Console

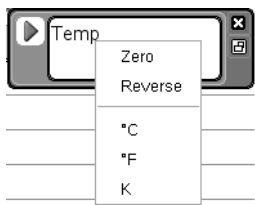
You can navigate and use the buttons on the Data Collection Console in the following ways:

- Move to the Data Collection Console to make its buttons available .When you are using a TI-Nspire™ application and not collecting data, the Data Collection Console becomes inactive and appears dimmed (transparent).
- The Data Collection Console buttons are available only when a sensor is attached.

- With the Data Collection Console is active, press **(tab)** to move among the buttons; click with the NavPad to use buttons.
- Click and drag the Data Collection Console to the location of your choice in the work area. Use grab or **(ctrl)+Click** to move and position the Data Collection Console when you need to view the work space for an application.
- Click the **View** button to switch between the large and small views of the Data Collection Console.
- Navigate between TI-Nspire™ applications and the Data Collection Console by pressing **(ctrl) (tab)**.



Accessing the context menu




The Sensor-specific options on the Data Collection Consoles's context menu are available when the console is active. In the following example, the context menu for a temperature sensor includes options for setting the Sensor to zero, reversing the calibration coefficient, and changing the units to Celsius, Fahrenheit, or Kelvin:





Data Collection Console buttons

When the Data Collection Console is active, you can click the following buttons on the console to change operation:




Button	Action	Description
	Start Data Collection	Begins data collection.
	Stop Data Collection	Stops data collection. The graph of existing data points is shown. For motion experiments, velocity and acceleration data for the points are also available.

Button	Action	Description
	Keep	Displays the measurement that is currently on the Data Collection Console in supported TI-Nspire™ applications on the current page. This button displays on the Data Collection Console's meter only when Events with Entry or Selected Events is the operation mode.
	Close	Closes the Data Collection Console. Pressing this button while data collection is in progress ends data collection. Pressing the button while data collection is in progress displays a dialog that lets you stop data collection or cancel closing. If you close the console, the points or values for data collected remain. Note: During motion experiments, closing the console prevents Data Collection from providing velocity and acceleration data.
	Change View	Changes the size of the Data Collection Console to Large or Small.

Data Collection Console menus

Icon	Menu	Option	Description
	1:Experiment	1:Start Collection	Starts the collection of data from a connected Sensor.
		2:Keep 	Keeps the data currently being measured. This option is available when Events with Entry or Selected Events is specified for the Set Up Collection option. Press Keep to indicate that you want to capture the data displayed on the console. For Events with Entry , you must assign the x value for the dependent variable.
		3:Set Up Collection	Lets you select a data collection: <ul style="list-style-type: none"> • Time Graph: Capture data with respect to time. • Events with Entry: Capture data and manually provide the x-value for the dependent variable. • Selected Events: Capture data based on the number of times Keep is pressed, using an automatically assigned, sequential independent y value for the independent variable.
		4:New Experiment	Delete all previously collected data from the data collection variables and use the default sensor configuration settings to start a new experiment.



Icon	Menu	Option	Description
		5:Display Data In	<p>Lets you choose where the data collected is displayed:</p> <ul style="list-style-type: none"> • App(s) on Current page: Modifies the supported applications on the current page to display data that a sensor collects. This option is grayed out if the current page contains no application for displaying data. • New Data & Statistics: Opens a new Data & Statistics page to display the data collected. • New Graphs & Geometry: Opens a new Graphs & Geometry page to display the data collected. • New Lists & Spreadsheet: Opens a new Lists & Spreadsheet page to display the data collected.
		6:Set Up Launch	<p>Specifies the application to be added when the Data Collection Console launches:</p> <ul style="list-style-type: none"> • Data & Statistics: Auto Launch the Data Collection Console with a new Data & Statistics application. • Lists & Spreadsheet: Auto Launch the Data Collection Console with a new Lists & Spreadsheet application. • Graphs & Geometry: Auto Launch the Data Collection Console with a new Graphs & Geometry application. • None (Meter Only): Auto Launch the Data Collection Console without adding an application. • Ask Me: With each Auto Launch of the Data Collection Console, ask which application to add.

Icon	Menu	Option	Description
	2:Sensors	Zero	Sets a zero reference based current experimental conditions. Setting Zero affects all data collection.
		Reverse	Reverses the calibration coefficient. This changes a positive measurement to negative.
		Change Units	Sets one of the supported units for the sensor.
	3:Data	1:Store Run	Saves the data for experiments using the default variable names. Data collection names variables using the format: <i>DC01.sensor1</i> or <i>DC01.time</i> . In the default variable names: <ul style="list-style-type: none"> <i>DC01</i> is the group designator for Data Collection. <i>Sensor1</i> is the member designator that indicates the type of data being collected (such as time or force.) <i>Time</i> is a member designator that indicates the time at which the sample was collected, in seconds. <p>Note: If you are using Selected Events or Events with Entry as the Set Up Collection setting, the <i>Time</i> variable contains either manually-created or sequential data. See Set Up Collection for more information.</p>
		2:Clear All Data	Clears all of the data collection variables, including those saved using the Store Run option. Clear All Data keeps all of the data collection and sensor settings for another run.
	4:View	1:Large	Changes the size of the Data Collection Console to Large.
		2:Small	Changes the size of the Data Collection Console to Small.


Running an experiment and collecting data

1. Prepare for data collection by attaching a supported USB sensor in one of the following ways:
 - Attach the sensor to the computer with the TI-Nspire™ software open
 - Attach the sensor to the TI-Nspire™ handheld

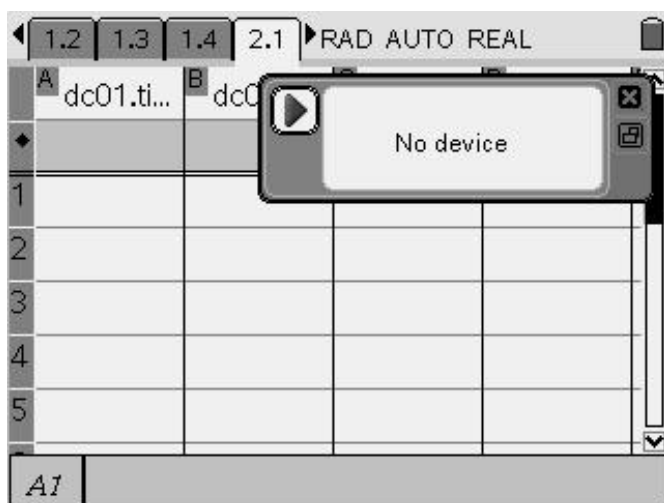
If the Sensor launches automatically, choose the application that you want to use for data collection, or close the Auto Launch dialog and set up the page manually as described in the next step.

2. Set up a page to include the application you want to use to display sensor data during collection.
3. Press   to launch a Data Collection Console.

The Data Collection Console displays in the work area. In the following example, a temperature sensor is displaying a measurement, but data is not being collected.

4. To make the applications on the page respond to data collection, choose **Display Data In > App(s) on Current Page** on the **Experiment** menu.
5. To make the applications on the page respond to data collection, press  to access the context menu for data collection. Press 1 5 1 to choose **Display Data In** from the **Experiment** menu and select **App(s) on Current Page** to make the applications respond to data collection.

In the following example, the application has been modified to respond to data collected by a temperature sensor:





Note: Press $\text{(ctrl)} + \text{(tab)}$ to move from the Data Collection Console to the other applications on the page.

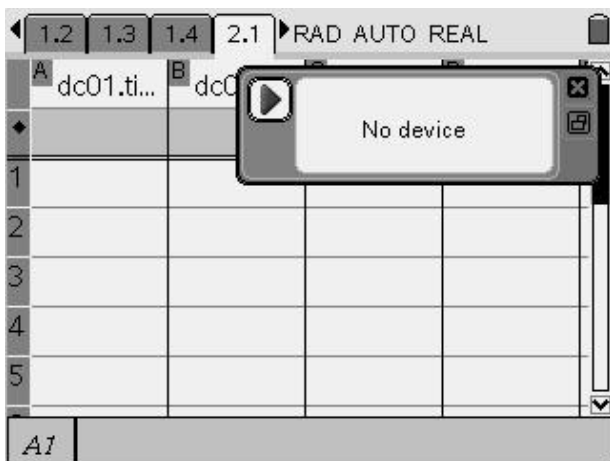
The Lists & Spreadsheet application and the Data & Statistics applications are labeled with the variable names for data collection. Variable names are used as column headings in Lists & Spreadsheet used for the axis labels in Data & Statistics.

- To select **Set Up Collection** on the **Experiment** menu and choose **Selected Events** as the operating mode for data collection:

Press 1 3 3.

For this example, Selected Events is the operating mode. This mode requires you to press **Keep** each time a measurement you want to include in the run is displayed on the Data Collection Console.


- With the Data Collection Console active, press (tab) to move to the **Start** button  and click the NavPad.
- Press **Keep**  on the Data Collection Console to collect a sample. An automatically assigned sequential event number displays and applications will populate a row in a spreadsheet or plot the corresponding data point on the axes of supported graphing applications.




9. Repeat Step 9 until you have collected data for each the sample that you want to use in the experiment.

After the value for each data point collected is added to a cell in the appropriate column for the variable and each corresponding data point is plotted on the axes, the page looks like the following example.

Note: The graphed data and collected values from a sensor are not editable. For example, if you attempt to edit a temperature measurement in a Lists & Spreadsheet cell, an error message displays. Press **Esc** to exit edit mode and clear the message.

You can press **Stop**  to stop the collection of data at any time during the experiment. With the Time Graph operating mode, the experiment ends after the duration set for the experiment is reached; data collection ends automatically.

10. To rerun the experiment without retaining the current data, press **Start** (). The data displayed is erased when the new experiment is started.

Note: When you press **Start**, an Overwrite Data message displays, warning you that the existing data will be lost.

- Select **Discard** to clear the latest run and start the new run.
- Select **Store** to store the latest run and start the new run.

Data Collection variable names




You can save the data collected for an experiment by storing the run or by saving the document that contains the problem. Data is stored in a variable and is accessible whenever you work on the problem that contains the Data Collection variables.

The naming system for Data Collection data includes a group designator and a member designator (group.member). For example, in a temperature versus time experiment, the data is named *DC01.temp1* and *DC01.time*. Remember that TI-Nspire™ computer software is not case sensitive: *DC01.TEMP1* and *dc01.temp1* reference the same set of data.



Storing collected data

Store the data collected during a run to mark the completion of part of an experiment. To save the current data before starting another run, perform the following steps.

1. With the Data Collection Console selected, press **Menu** to access the Data Collection menus.
2. Click **Store Run** on the **Data** menu to save the collected data.

Note: Press  to move among the controls on the Data Collection Console. Press   if you need to move from an application to the Data Collection Console.

You can also clear the data for a run, or access the variables that store data:

- To remove all data for experiments and start over, select **New Experiment** or use a new problem. The Data Collection Console settings and previously collected data remain accessible when you use a new problem. Although other problems contain data from previous runs, only the current problem communicates with the sensor during data collection.
- To access variables that hold the data collected during a run from other applications, choose the variable name from the VarLink menu. For example, to access the values in *dc01.temp*, press   and select the variable from the menu.

Retrieving stored experimental results

To review stored experimental data, open the document that contains the data. Refer to the chapters for Lists & Spreadsheet, Graphs & Geometry, or Data & Statistics for more information about using those applications with data collected.

Troubleshooting the Data Collection Console

Following are some of the most common situations you might experience along with guidelines for correcting them.

Sensor was not detected by TI-Nspire™ software when connected to a TI-Nspire™ handheld or computer.

- Check that the sensor connectors are completely inserted into the handheld/computer.
- Unplug the sensor then reconnect it. This should restart the communication link.

Low batteries

This message displays when the batteries in your Vernier Go!®Motion or CBR2™ unit are low. Replace the batteries at the next convenient opportunity.

Note: If you connect these sensors to your computer, batteries are not required. The sensors will obtain their power from the computer by way of the USB port.

Bad batteries: <hardware name>

This message displays when the batteries in your Vernier Go!®Motion, CBR2™, or TI-Nspire™ handheld are too low to continue data collection. Consult the Battery Information section of this manual or your sensor's manual to replace them.

Communication Failure

This message displays when communication is disrupted between the TI-Nspire™ handheld or TI-Nspire™ computer software and the connected data collection device. Check all connections and power, then restart the Data Collection Console.

Data Collection Conflict.

This message displays when another computer application is managing data collection. To collect data using TI-Nspire™ computer software, close the other data collection application and restart the TI-Nspire™ software.

Unsaved Data.

This message displays when you start a Data Collection experiment and you already have data present from a previous run. To save the existing data, click **Store** on the **Unsaved Data** dialog. To delete the data collected in the previous run, click **Discard**.

Device not found.

The expected data collection device was not found. This message displays when you open a document that had a Data Collection Console open, and either no sensor is connected or the wrong sensor is connected. To correct the error situation, check that the sensor is properly connected to the device or handheld. If the appropriate sensor is firmly attached, close the document and then reopen it.

Error.

This message displays when an unexpected error occurs that in some way interferes with the Data Collection Console. Data Collection is terminated. Verify that all connections and batteries are good, then retry the experiment.

Appendix: Service and Support

Texas Instruments Support and Service

For general information

For more information about TI products and services, contact TI by e-mail or visit the TI Internet address.

E-mail inquiries: ti-cares@ti.com

Home Page: education.ti.com

Service and warranty information

For information about the length and terms of the warranty or about product service, refer to the warranty statement enclosed with this product or contact your local Texas Instruments retailer/distributor.

Service

Refer Servicing to Qualified Service Personnel under the Conditions Listed Below:

- If liquid has been spilled or objects have fallen into the product.
- If the product has been exposed to rain or water.
- If the product does not operate normally as per the operating instructions.
- If the product has been dropped or the case has been damaged.

Battery Precautions

Take these precautions when replacing batteries.

- Do not leave batteries within the reach of children.
- Do not mix new and used batteries. Do not mix brands (or types within brands) of batteries.
- Do not mix rechargeable and non-rechargeable batteries.
- Install batteries according to polarity (+ and -) diagrams.
- Do not place non-rechargeable batteries in a battery recharger.
- Properly dispose of used batteries immediately.
- Do not incinerate or dismantle batteries.

Disposing of Batteries

- Do not mutilate, puncture, or dispose of batteries in fire. The batteries can burst or explode, releasing hazardous chemicals. Discard used batteries according to local regulations.

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